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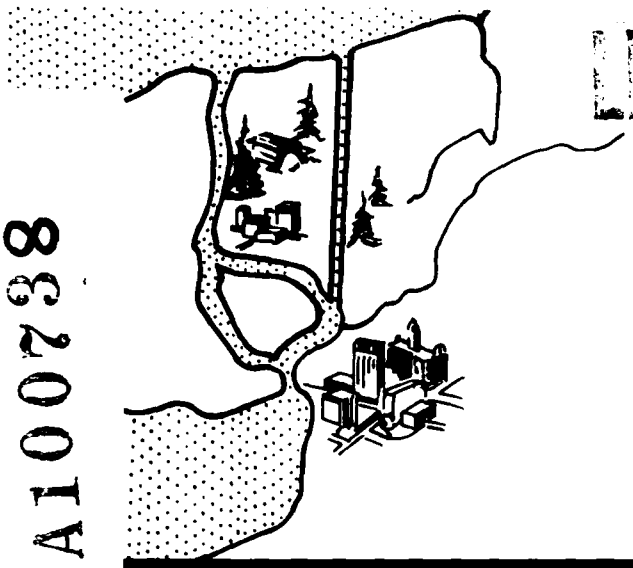

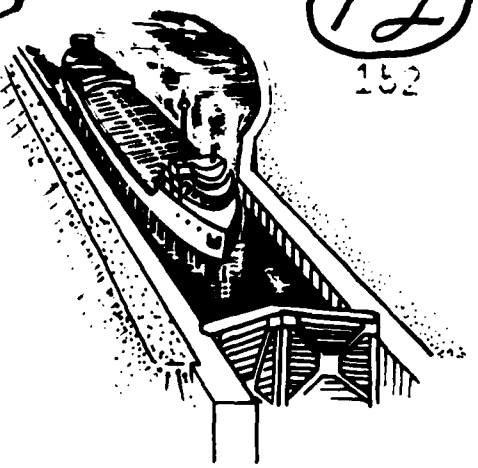

REVIEW of REPORTS

on

LAKE ERIE - LAKE ONTARIO WATERWAY N.Y.

APPENDIX A
DESIGN AND COST ESTIMATES

U.S. ARMY CORPS OF ENGINEERS
BUFFALO DISTRICT

OCTOBER 1973

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The purpose of this review is to examine the conclusions from the environmental, engineering and economic studies of the construction of a water way between Lake Erie and Lake Ontario in the United States. This report will also serve as a basis for further action by Congress.

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REVIEW OF REPOPTS

ON

LAKE ERIE - LAKE ONTARIO WATERWAY

APPENDIX A

DESIGNS AND COST ESTIMATES

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SECTION I - CANAL AND LOCK DESIGN

A-I.1. Canal Alignment. The proposed canal alignment, designated A-1, is shown on plates A1 through A8. The proposed canal consists of two sections, the Niagara River Section and the Overland Section. The Niagara River section of the canal follows the existing Black Rock Canal route from Buffalo Harbor to a point just north of Tonawanda Island. From this point, the Overland section of the Canal follows the shortest generally north-south route to Lake Ontario with necessary deviations to avoid existing population centers and to obtain optimum compatibility with the geological and topographical features of the area. The centerline of this alignment has been established by station and coordinates based on the New York coordinate system, west zone, as indicated in Table A1.

A-I.2 Alternate Canal Routes Studied. Six alternate overland routes have been studied in some detail. Four of these routes were eliminated by the early studies. The remaining two routes, designated A-1 (the proposed alignment) and C-2, were studied in further detail. The two routes have a common alignment from Buffalo Harbor to a point on the Overland section, about three miles north of the Niagara River. The two alignments separate at this point, with the C-2 alignment crossing the escarpment about two and one-half miles to the east of the A-1 alignment. The A-1 alignment is proposed because:

1. It is about one mile shorter than the C-2 alignment.

2. Probing data indicates a top of rock profile more adaptable to lock locations.

3. The first lock located at the escarpment appears to afford a better opportunity for providing necessary surge basins.

4. Relocations along A-1 alignment appear to be less complicated and less expensive.

TABLE A1 - ALIGNMENT INTERSECTION DATA

New York Coordinate System, West Zone.

Intersection No.	Station	Coordinates North	East
PI-1	328+54.07	1,050,333	417,170
PI-2	343+91.07	1,050,870	417,170
PI-3	389+78.33	1,055,200	414,015
PI-4	432+63.39	1,059,470	414,374
PI-5	462+61.91	1,062,468	414,318
PI-6	489+63.00	1,065,100	414,925
PI-7	569+93.71	1,072,485	411,770
PI-8	622+09.84	1,077,518	410,400
PI-9	706+61.77	1,083,565	404,495
PI-10	739+93.93	1,086,685	403,325
PI-11	782+86.75	1,090,922	404,015
PI-12	821+49.77	1,093,978	406,378
PI-13	859+17.36	1,096,300	409,345
PI-14	937+07.72	1,099,400	416,492
PI-15	956+04.22	1,100,862	417,700
PI-16	978+06.34	1,103,026	418,108
PI-17	998+54.99	1,105,000	417,560
PI-18	1103+85.43	1,115,000	414,260
PI-19	1210+85.43	1,125,700	414,260
PI-20	1242+43.60	1,128,771.78	414,993.64
PI-21	1267+27.08	1,131,187.32	415,570.55
PI-22	1410+65.08	1,145,430.00	413,920.00
PI-23	1565+00	1,160,652.06	416,474.51
PI-24	2000+00	1,202,046.42	403,104.50

A-I.3 Lock Locations. Three schemes, a four lock system, a five lock system, and a six lock system, were considered for alignment A-1 and C-2. These schemes provide one lock located at Squaw Island in the Niagara River section and three, four, and five lock combinations located from the escarpment to Lake Ontario in the Overland section. Studies of these systems included: foundation investigations, hydraulic

studies of filling and emptying systems (including surge basins), structural and mechanical designs, and relocations. The four lock scheme was eliminated due to the unusually high lift (107 feet) and to uncertain foundation conditions for the locks located in the Overland section. The five and six lock systems were studied in more detail. The five lock system is proposed as providing the optimum arrangement based on foundation conditions, structural requirements, hydraulic requirements, relocation requirements, and general topography of the area. The proposed lock locations are shown on Plates A2 through A8.

A-I.4. Canal Dimensions. Canal dimensions and typical sections are shown on Plates A2 through A10. Present standards in the Great Lakes System, above Lake Erie, require a minimum depth of 27 feet and a minimum bottom width of 600 feet for two-way canal traffic. Minimum canal channel depth for this study was set at 30 feet, in anticipation of future deepening of connecting waterways. Basic canal channel dimensions, as set for this project, are described hereinafter:

a. Existing Buffalo Harbor entrance channel from Lake Erie to the canal entrance - present width 800 feet, to be deepened to 30 feet.

b. From canal entrance to upper end of Lock 5 - 600 feet wide by 30 feet deep.

c. Lower end Lock 5 to the Overland section entrance - 30 feet deep by 700 feet wide, except for a short narrowed section 400 feet wide at the South Grand Island Bridge Piers and a widened section 800 feet wide at the entrance to the Overland section.

d. From the Niagara River to the escarpment (Lock 4) - 30 feet deep by 500 feet wide with provisions for future widening to 700 feet.

e. From the escarpment (Lock 4) to the upper end of Lock 1 - 30 feet deep by 700 feet wide.

f. Lower end of Lock 1 to Lake Ontario deep water - 35 feet deep by 700 feet wide.

g. Widening at bends - 10 feet per degree of bend deflection where possible.

A-I.5. Lock Dimensions. Typical details and dimensions of proposed locks are shown on Plate All. For this study lock dimensions have been set at 110 feet wide by 1,200 feet center-to-center of operating miter gate pintles and 892 feet to center of intermediate miter gate pintles. Minimum depth over lock sills has been set at 35 feet. These are minimum dimensions based on the Poe Lock of the St. Marys Falls Canal and a maximum sized ship having a beam of 105 feet and a length of 1,000 feet. Future developments relative to improvements in the Great Lakes System and improvements in ship design may require revision of these dimensions during future studies. Upper and lower guide walls, 2,000 feet long, will be provided at each lock. The locks will be offset 295 feet, centerline locks to centerline canal, to allow for possible future parallel locks. The Black Rock lock will have a nominal lift of 5 feet, and the four high-lift Overland section locks will have nominal lifts of 80 feet each.

A-I.6. Lock Features. Typical lock features and details are shown on Plate All and are as described hereinafter:

a. Gates. Locks 1 through 4 will each have four sets of miter gates, consisting of one upper gate, two lower gates and a spare upper gate at the lower end for unwatering. The intermediate lower gate

will be used to handle vessels up to 730 feet in length. Such vessels will predominate in the early years of the canal. Also, the intermediate gate will reduce lockage water and subsequent loss to hydroelectric plants. Lock 5-5 will have the same arrangement of miter gates as the other four locks, except that the intermediate lower gate will be deleted.

b. Filling and Emptying System. Filling and emptying of the locks will be through the two culverts provided for each lock. The culverts of Locks 1-5 through 4-5 will be connected to surge basins separated from the main canal by dikes. The culverts of Lock 5-5 will take in water from the lock above the upper miter gate and discharge water to the lock below the unwatering gate. A longitudinal bottom lateral filling and emptying system will be provided in the bottom of Locks No. 1 through 4. A transverse filling and emptying system will be provided in the bottom of Lock 5-5.

c. Pool Level Sensors and Controls. Each lock will have two control houses. They will be located on top of the lock walls, one at the upper gate and one at the lower gate. From these houses the operator will control the miter gates, tainter gate culvert valves, wire rope fenders, and ship passage through the locks.

There will be water level sensors at each lock to measure the changing differential between upper or lower pool and lock chamber water elevation. The data from these sensors will enable the lock control house operator to sequence the tainter valve operations automatically or manually to minimize surging during filling and emptying period. These data will also be relayed to the Central Traffic Control Building.

d. Bulkheads and Hoists. Emergency closure at the upper ends of the locks will be by bulkheads handled by a permanent in-place hoist.

Closure at the lower ends of the locks, normally accomplished with the unwatering gate, will have the additional provision for bulkheads lowered in place from a floating barge. Lock 4, the first lock north of the Niagara River at the Niagara Escarpment, will be also provided with a vertical lift gate at the upper end of the lock. The gate will be designed for emergency closure under head, and will prevent loss of large quantities of Niagara River water in the event of major damage to the miter gates of Lock 4. Bulkheads for the upper lock closure will be stored on top of the lock walls adjacent to the hoist. Bulkheads for the lower closure will be stored at the central maintenance yard.

e. Mooring Facilities. Locks 1 through 4 will be provided with snubbing buttons and floating mooring bits for boat mooring. Due to the 5 foot lift, Lock 5 will be provided with snubbing buttons and mooring hooks only. Guide and guard walk will have snubbing buttons on top, spaced at regular intervals.

f. Gate and Wall Protection. Wire rope fenders which protect the miter gates from damage by ships in transit, will be provided upstream of the upper miter gate, upstream of the intermediate lower gate, and downstream of the lower gate at Locks 1 through 4. At Lock 5, the fenders will be located upstream and downstream of the upper and lower gates. The fenders will be raised and lowered by metal booms to allow for boat passage and will operate hydraulically. Each culvert will have conventional twin reverse tainter gate valves to control flow. The filling valves will be located in the lock walls in the vicinity of the upper gate. The emptying valves will be located in the vicinity of the lower gates. Each valve will have provision for bulkheads immediately

upstream and downstream so that the culvert may be dewatered in the valve area. Wall armor will be provided in the vertical face of one lock wall. Timber fenders will be provided in the upper portion of the guard walls, guide walls, and miter gates.

g. Cold Weather and Ice Prevention Facilities. Facilities for deicing will include steam or electric deicing of all miter gates except the unwatering gate, a compressed air bubbling system across the front of all miter gates except the unwatering gate, and internal steam deicing of the sides of the lock walls in the vicinity of the upper pool level to eliminate ice formation caused by alternate wetting of these areas during each lockage. In addition to the gate recess in the miter gate monoliths, there will be an ice egress recess to facilitate the opening of the gates during the ice season.

h. Standby Power Facilities. Each lock will be provided with an emergency standby motor generator power source, capable of supplying normal operating power demand that will start automatically in the event of a power failure.

i. Esplanade and Miscellaneous Features. Locks 1 through 4 will have an esplanade measuring approximately 380 feet by 400 feet on each side of each lock, as shown on Plate All. Each esplanade will have vehicular access with parking for approximately 350 visitors' cars. Lock 5, the Black Rock Lock on the Niagara River, will have a 60 foot by 350 foot esplanade on the landside of the lock to provide parking and work space for the employees. One Operations Building will be provided in the esplanade area of each lock with parking for approximately 18 employees' cars. One visitors' Observation Building with walkway access

will be provided at each lock except Lock 5. The esplanade and visitors' area will be secured from the lock itself by chain link fencing, with gates at the roads. All access roads and parking areas will be paved with blacktop, and will have concrete curbs. Areas of the esplanade not paved will be landscaped and seeded. There will also be maintenance access roads at each side of the lock to the lower lock walls. There will be an elevator from the upper to the lower lock wall for use by operating and maintenance personnel. Locks 1, 2, and 3 will have a tunnel through the upper miter sill to provide for various roads and the New York Central Railroad crossing the locks.

A-I.7. Canal Operations and Maintenance Facilities. There will be an area complex, adjacent to the canal and to Lake Ontario, in the vicinity of Lock 1 which will contain the Administration Building, Traffic Control Facilities, Maintenance and Warehouse Building, and the mooring basin for marine equipment.

a. Administration Building. The Administration Building will contain approximately 30,000 square feet of office space for administrative personnel.

b. Standby Power. The whole operation and maintenance complex will be provided with a standby motor generator power source that will start automatically in event of a power failure.

c. Traffic Control Facilities.

(1) Canal Traffic Control System. The canal traffic control system will consist of an audio-video monitoring system for direct central control of all canal traffic and operations, and an automated computerized system for automatically and continuously displaying, on a central animated

control console, weather data, pool elevations, the status of all pertinent lock functional operations, and the location and status of all shipping in the canal. An operations area or building, of approximately 5,000 square feet, will be provided to house the centrally located computer, control console and related equipment and operating personnel. The video portion of the system will consist of closed circuit television receivers with video tape recording equipment and television cameras equipped to rotate 360 degrees, having zoom lenses and high intensity narrow beam lights for night viewing, mounted on towers at all locks and along all reaches of the canal. The audio portion of the system will be equipped with tape recording equipment to record all conversations pertaining to instructions regarding passage of ships through the canal channel and locks and the functional operation of lock components. Weather data, pool elevations status of functional operation of lock components, and locations of shipping will be transmitted continuously by suitable means to the computerized central control console for display.

(2) International Great Lakes Traffic Control System. The St. Lawrence Seaway Authority of Canada is developing an Integrated Marine Traffic Information and Control System (IMTIC) for the purpose of more efficient planning and control of the use of the facilities of the St. Lawrence Seaway. The system has evolved from a continuing study of traffic, control and traffic information problems, primarily on the Canadian facilities on the St. Lawrence Seaway, but has the flexibility to integrate or expand into a single Great Lakes Control System. Cooperation or integration with the Canadian system would appear mandatory for the proper utilization of the proposed waterway.

d. Canal and Surge Basin Pool Controls. "Navigation Pool Level Gages"and the"Control of Intermediate Pool Levels in Overland Section" are described in detail in Paragraphs C-II.50. and C-II.51. of Appendix C. The data from the pool level gages at each lock will be transmitted via telemetry to the Traffic Control Building. At this point the data will be coordinated through a computer and instructions given to each lock regarding operation of the gates on the supply culverts to maintain proper pool levels.

e. Maintenance and Warehouse Building. The Maintenance and Warehouse Building will contain approximately 80,000 square feet of office, warehouse, shop, and garage space. The maintenance area will contain engineering offices, machine, carpentry, paint, electrical, welding shops, and storage for surveying, sounding, snow removal, lawn care, and portable pumping equipment. An overhead traveling crane, hoists, and truck scale will be provided. The warehouse area will maintain an inventory that will include piping, fenders, spare parts, small tools, electrical supplies, cables, castings, fencing, railing, and paint supplies.

f. Land Equipment. Land based rolling stock will include cars, trucks, vans, tractors, cranes, and compressors.

g. Mooring Basin. The mooring basin for marine maintenance equipment will be an enclosed area with a water surface measuring approximately 200 feet by 700 feet located within the confines of Lake Ontario harbor as shown on Plate A8. There will be a boathouse with three bays equipped for servicing small boats out of water. The tops of the basin perimeter walls will be wide enough for the transit of service equipment, and will have snubbing buttons at regular intervals for mooring. Marine

maintenance equipment moored at this location will include one gate lifter and barge, sweep, flat, probe and dump scows, dredge barges, tugs, and survey boats.

A-I.8. Lock Walls.

a. Description. All the lock and guide walls are designed as gravity type monoliths. Controlling elevations of the top of the upper and lower lock walls and miter sills, upper and lower pool elevations, plus waterway stationing to the centerline of the upper miter gate pintle are shown in Table A2.

b. Design Criteria. Criteria for lock stability analysis are listed in Table A3. Design constants for the Queenston Shale foundation material as developed in Appendix B - Geology, Soil and Materials, are as follows:

Angle of Internal Friction	Tan ϕ = 0.700
Allowable Compressive Strength	33 tons per sq ft
Modulus of Elasticity "E"	390,000 psi
Unit Weight	165 lb per cu ft
Coefficient of Friction-Sliding	Tan μ = 0.30

A-I.9. Bird Island Pier.

a. Description. Removal and replacement of a portion of the existing Bird Island Pier upstream of Squaw Island in the Niagara River section of the canal is necessary to provide the required channel width of 600 feet. The new section of the pier will be approximately 7,540 feet long with top elevation of 572.5 I.G.L.D. and an average height of 21.0 feet above rock foundation. Basic construction will be rock filled, concrete capped, steel sheet pile cells having a diameter of 30.5 feet.

General layout of the pier is shown on Plate A2. Typical pier cross section is shown on Plate A6.

b. Design Criteria. The design of the Steel sheet pile cells is based on design criteria and procedures set forth in Engineering Manual, EM 1110-2-2904, Design of Breakwaters and Jetties. Maximum height of cells above rock for design is 28.0 feet. Maximum design water level differential is 5.0 feet.

A-I.10. Overland Section Dikes.

a. Description. In the Overland section of the canal, between the escarpment and Lake Ontario, dikes are required to contain and separate the channel and surge basins so that the canal level can be lowered from the Niagara River level to the Lake Ontario level in four equal lifts. The dikes will be the rock fill type having a 20.0 foot top width and 1 vertical to 1-1/2 horizontal side slopes. All exterior dike walls are provided with impervious earth cores. Where dikes exceed critical height, rock or rock-protected earth or shale toe fills are provided for stability purposes. Width of toe fills varies with the height of the dikes. There are four separate reaches of dikes north of the escarpment. Table A4 lists data relative to the dikes in each reach.

TABLE A2 - CANAL LOCKS

Lock No.	Top-Upper Lock Wall	Top-Lower Lock Wall	Minimum Upper Pool Elevation	Minimum Lower Pool Elevation	Top-Upper Miter Sill	Top-Lower Miter Sill	Waterway Station - Upper Miter Gate Pintle
1	331.7	252.0	321.7	242.8	285.8	205.8	1944 + 00
2	411.4	331.7	401.4	321.7	366.4	285.5	1797 + 00
3	491.1	411.4	481.1	401.4	446.1	365.2	1628 + 90
4	572.0	491.1	562.1	481.1	526.1	446.1	1552 + 00 (Approx.)
5	580.0	575.0 (Guide Wall)	568.6	563.7	528.7 (Max.)	528.7 (Max.)	519 + 81

TABLE A3. Lake Erie-Lake Ontario Waterway

Navigation Lock Stability Analysis Criteria

Loading Condition	Case	Wall	Pressure Condition	Overturn Direction	Min. Base Area in Compression	Min. Shear-friction Safety Factor	Remarks
Normal Operating Upper pool in chamber S.L. = Lower pool	IA		Active	Landward	100%	4	
Normal Operating Lower pool in chamber	1B-1		Active	Toward lock	100%	4	
S.L. = Lower pool	1B-2		At-rest	Toward lock	75%	3	
Extreme maintenance Chamber unwatered	IIA-1		Active	Toward lock	75%	2-2/3	
S.L. = Lower pool	IIA-2		At-rest	Toward lock	50%	2	
Extreme emergency Cases 1A with earthquake	IID		-	Landward	*	2-2/3	
Extreme emergency Cases IB with earthquake	IIE-1		Active	Toward lock	*	2-2/3	
	IIE-2		At-rest	Toward lock	*	2	
Construction	IIIA		-	Toward lock	75%	-	
No hydrostatic forces No earth	IIIA		-	Toward lock	75%	-	
Construction No hydrostatic forces	IIIB		Active (moist)	Toward lock	75%	2-2/3	

* Resultant must be a reasonable distance inside the base and not exceed the allowable foundation pressures

Table A4

CANAL DIKES

Reach	Top Elevation Feet	Top Toe Fill, Feet	Maximum Dike Height, Feet	Total Length of Dikes, Feet
Locks 1 to 2	331.7	291.5	62	36,300
Locks 2 to 3	411.4	355.4	110	41,700
Locks 3 to 4	491.1	435.1	100	14,300
Lock 4 to Escarpment	572.0	-	38	8,900

General layout of the dikes is shown on Plates A7 and A8. Typical dike cross sections are shown on Plates A9 and A10.

b. Design Criteria. Design criteria for the design of the dikes is included hereinafter.

(1) Wave Protection. All surfaces of the dikes subject to ship and/or wind wave action will be protected with suitable size range and thickness layers of armor stone and riprap protection, designed in accordance with the applicable design criteria and procedures set forth in Engineering Manual, EM 1110-2-2904, Design of Breakwaters and Jetties and Technical Report No. 4, Shore Protection, Planning and Design.

(2) Stability Analysis. Stability and seepage analyses are covered in detail in Appendix B - Geology, Soil and Materials.

A-I.11. Surge Basins. Except for the emptying of Lock 1, Locks 1 through 4 are filled from and emptied into surge basins located adjacent to the canal channels and connected thereto by 100 flow

restricting culverts, each 5 feet in diameter. Based on the restricted flow through the culverts, the surge basins are designed to provide sufficient surface area relative to the surface area of the canal channels to permit rapid emptying and filling of the locks without producing unsafe surge heights in the canal channels. Surge basin areas required for the various reaches of the canal channel and details of the culvert design are covered in detail in Appendix C - Hydrology and Hydraulic Design. General layout and details of surge basins and culverts are shown on Plates A7 through A10.

A-I.12. Drainage Structures and Relocations.

a. Bergholtz Creek Drop Structure. Approximately 10 square miles of the Bergholtz Creek watershed, situated south of the escarpment and east of the proposed waterway, would become tributary to the Overland section of the canal. A concrete drop structure and stilling basin designed for the runoff from a 50 year storm will be provided. The drop structure and stilling basin will introduce the creek flow into the canal channel without serious hazard to navigation. While a drop structure and stilling basin offer the most economical means of handling the creek flow, an inverted siphon would be considerably more desirable from the environmental and construction drainage point of view. Future studies should give serious consideration to the use of an inverted siphon for the Bergholtz Creek crossing.

b. Twelvemile Creek Inverted Siphon. Approximately 11.5 square miles of the Twelvemile Creek watershed situated north of the escarpment and west of the proposed waterway, would be cut off by the

Overland section of the canal. An inverted siphon designed for the runoff from a 50 year storm will be provided to pass the creek flow under the canal. The length of the siphon would be sufficient to permit construction of a future surge basin on the east side of the canal. A 2.5 mile long diversion channel along the west side of the canal to Lake Ontario would provide a slightly more economical solution. However, the adverse environmental impacts are considered to outweigh the economical advantage.

c. Miscellaneous Drainage Structures and Diversions. A number of permanent small stream drop structures and diversions will be required along the Overland section of the canal. Design of these structures and diversions, and any temporary construction drainage structure, diversions and other facilities would be as necessary to satisfy economical and environmental considerations.

d. Temporary Control Structure at Entrance to Overland Section. A temporary control structure located at the Niagara River entrance to the Overland section of the canal will be provided to control flow into the canal channel at the completion of construction. The control structure would be designed to provide a flow of 1,000 cfs to 2,000 cfs, and would permit filling of the canal channel north of the escarpment in one to two weeks. After completion of the filling operation, the control structure would be removed and the entrance plug would be removed by dredging operations.

A-I.13. Lake Ontario Harbor.

a. Description. The harbor will contain approximately 1,650

acres of water surface area with a minimum project depth of 30 feet. The harbor area will be enclosed by a stone rubble mound breakwater with an arrowhead entrance. The rubble mound breakwater will be approximately 30,250 feet long with top elevation of 17.0 feet LWD, side slopes of 1 vertical on 1.5 horizontal, and a height ranging from 17.0 to 78.0 feet, including displacement of approximately 2.0 feet of bottom sediment. Basic construction consists of a quarry-run stone core protected by 13.25 feet and 11.5 feet thicknesses of primary and secondary armor stone on the lake and harbor sides, respectively. General layout of the harbor area is shown on Plate A8 and typical breakwater cross sections are shown on Plate A9.

b. Breakwater Design Criteria. Design criteria, assumptions and procedures for the design of the breakwater are included hereinafter.

(1) Wave Protection. Basic configuration of the breakwater cross section and size ranges of the armor protection stone and the core material are based on design criteria and procedures set forth in Technical Report No. 4, Shore Protection, Planning and Design. Primary armor stone was designed on the basis of the following data:

Deep Water Wave Height	12.0 feet
Deep Water Wave Period	8.5 seconds
Still Water Level SWL	5.0 feet LWD
Stone Unit Weight	155 lbs per cu ft
Stone Specific Gravity	2.48

(2) Stability Analysis. The breakwater dike is founded directly on Queenston Shale. No stability problems related to the foundation material are anticipated.

A-I.14. Use and Disposal of Excavated Material.

a. Construction Procedures. It is anticipated that the construction of the waterway will require approximately five years to complete, with the construction of the locks, harbor, channels, dikes, and appurtenances proceeding continuously and concurrently during that period. The work in the Niagara River section of the channel will be primarily a dredging operation and would proceed relatively independent of the work in the Overland section and Ontario Harbor. Work in the Overland section will be essentially a dry land cut and fill operation with materials excavated from the area south of the escarpment being used to construct the locks, dikes, harbor breakwater, and appurtenances located to the north of the escarpment. For purposes of this report, it was assumed that construction work in the Overland section would proceed as follows:

(1) Excavation and quarrying operations would begin at the escarpment and proceed south.

(2) An aggregate processing plant and storage facilities would be established at a convenient location near the escarpment.

(3) Haul roads would be established inside the canal right-of-way from the escarpment to Lake Ontario. The bottom of the cut section would be used as a haul road south of the escarpment.

(4) Construction of the harbor breakwater, dikes, and relocation fills north of the escarpment would proceed, in general, from Lake Ontario south toward the escarpment with construction of the locks proceeding concurrently.

b. Materials to be Used in Construction. The types and location of materials to be excavated and their suitability for use as construction materials are covered in detail under Construction Materials in Appendix B - Geology, Soil and Materials. A material quantity use and disposal summary of the rock, shale, and overburden materials excavated from the various sections of the waterway is presented in Table A5. The use of dredged materials for construction purposes is not considered to be economical, when compared to the use of similar materials excavated from the Overland section.

TABLE A5. EXCAVATED MATERIALS USE AND DISPOSAL BALANCE[1]

Material	Bank Excavation 1000 Cy	Embankment Fill 1000 Cy	Impervious Fill 1000 Cy	Breakwater Fill 1000 Cy	Concrete Aggregate 1000 Cy	Spoil Fill 1000 Cy
Niagara River Section						
Rock	4,969	--	--	197[2]	--	7,256
Shale	3,660	--	--	--	--	4,398
Overburden	19,226[4]	296[3]	--	--	--	18,878
Totals	27,856[4]	296	--	197	--	30,532[5]
Overland Section						
Rock	37,113	39,511[6]	--	6,759	9,530	0
Shale	9,499	10,231	--	--	--	1,169
Overburden	37,960[8]	23,713[7]	4,787	--	--	4,460
Totals	84,572	73,455	4,787	6,759	9,530	5,629[9]
Ontario Harbor						
Shale	9,533	--	--	--	--	11,450
Overburden	2,693	--	--	--	--	2,693
Totals	12,226[10]	--	--	--	--	14,143[11]
Grand Totals	124,654	73,751	4,787	6,956	9,530	50,956

(1) See Table A6 for ratio of excavated material volumes to undistrubed bank volume.
(2) Bird Island Pier.
(3) Esplanade Fill Lock 5 - Squaw Island.
(4) Dredged, except for small amount of dry excavation at Lock 5 - Squaw Island.
(5) Open lake disposal - Lake Erie.
(6) Includes bank protection.
(7) Includes explamade and relocation fills.
(8) Dry excavation only - does not include channel dredging below Lock 1.
(9) Materials, dry spoiled inside dikes between Locks 3 and 4.
(10) Dredged.
(11) Open lake disposal - Lake Ontario.

TABLE A6. VOLUME COMPARISON OF EXCAVATED MATERIALS

BASED ON UNDISTURBED BANK VOLUME

Material	Bank Cy	Loose Cy	Embankment Cy	Spoil Cy	Aggregate Per Cy Concrete Cy
Rock	1	1.5	1.5	1.5	0.88(1)
Shale	1	1.3	1.2	1.2	--
Overburden	1	1.15	.85	1.0	--

(1) 1.32 cy in terms of embankment volume.

c. Criteria For Material Dispostion. Disposal of excess dredged materials will be in the open lakes at depths of 40 feet or more, except that materials dredged from Ontario Harbor could be disposed of below project depth in the deeper areas of the harbor. Appendix E - Environmental and Recreational Studies presents evidence that polluted sediments are present in the existing Black Rock Canal and along the east shore of the Tonawanda channel of the Niagara River. It is anticipated that polluted sediments in the existing canal will be removed, or at least minimized, by normal Corps of Engineers maintenance dredging, and that the location of the new canal in the Tonawanda channel will avoid dredging of appreciable amounts of polluted materials in that area. Should appreciable amounts of polluted materials be encountered, disposal would be in contained diked disposal areas or other acceptable means. Excess materials from the Overland section will be spoiled in the surge basins and canal channels between Locks 3 and 4 and Locks 2 and 3, as necessary. Materials spoiled in this manner will be topped with a rock layer in order to reduce turbidity in the canal.

SECTION II - RELOCATIONS

A-II.1. Relocations. General criteria used for the new relocation of bridges, railroads, highways and utilities and for the adequacy of clearances at existing bridges and utilities based on St. Lawrence Seaway standards, accepted practice, and generally accepted standards for railroads and highways will be as follows:

a. 120 feet minimum vertical overhead clearance and 700 feet minimum horizontal clearance at all bridges and overhead utilities.

b. Top of all submarine utilities 5 feet minimum clearance below overdepth excavation.

c. Maximum railroad curve will be 1.5 degrees; maximum railroad grade will be 1.0 percent.

d. Maximum highway grade will be 4.0 percent.

e. No movable bridges will be considered on the Overland Section.

f. No local narrowing of the canal channel will be considered if solely for reasons of economy. The one exception to this rule is the channel width at the South Grand Island Bridge, which will be reduced to 400 feet to save the existing bridge piers.

g. Economic justification for the provision of a new bridge or tunnel for any existing highway will be based on a cost comparison to a detour route for the same facility. In order for a new bridge or tunnel to be economically justifiable, the cost amortized over 50 years plus annual maintenance and operation cost must be less than the cost of a detour route, amortized over 50 years plus annual maintenance, operation, and highway user costs. Any road cut by the new canal and not mentioned in this Appendix will have its traffic permanently detoured to the nearest available route.

h. All new bridges over the waterway will be properly lighted, with beacon lights atop towers and colored navigation lights on the underside of the span.

i. All relocation crossings along the cut reach of the Overland section are designed to permit future widening of the canal channel to 700 feet. North of the escarpment all affected relocation crossings are designed to permit construction of future docks and surge basin dikes.

RAILROADS

A-II.2. International Railroad Bridge. A new 110 foot clear span single-leaf bascule bridge will be provided, located in the present embankment approach to the main Niagara River crossing. The existing swing type bridge located just upstream of existing Black Rock Lock will not be removed. The new bridge will have a double track and a single lane roadway for access to outer Squaw Island. The piers will be located on top of the Lock 5 walls in the vicinity of the upper miter gate. Traffic will be maintained during construction. See Plate A3 for general location of the new railroad bridge.

A-II.3. Erie-Lackawanna Railroad, and New York Central Railroad Niagara and Falls Road Branches. These two railroads will be relocated as shown on Plate A5. The relocation will consist of a central canal crossing, a western approach and an eastern approach with northern and southern legs. The central canal crossing will be made up of two parallel, single track, 900 foot cantilever truss main spans with 280 foot side spans. The western approach will be made up of thirty-six 150 foot deck truss spans, and approximately 3,000 linear feet of double track embankment fill with a highway underpass at Walmore Road. The southern leg of the eastern approach,

parallel sections of the Erie-Lackawanna and Niagara Branch of the New York Central Railroads, will consist of approximately 3,300 linear feet of double track embankment fill, thirty-seven 150 foot double track deck truss spans and 20,300 feet of double track laid with minimal cut and fill with highway underpasses at Niagara Falls Boulevard and Errick Road. All other roads intersected, except at the southern terminus of the relocation, will either go under the deck truss spans or have grade crossings with automatic signals. The northern leg of the eastern approach, the Falls Road Branch of the New York Central Railroad, will consist of thirty-nine 150 foot deck truss spans, approximately 2,800 linear feet of embankment fill, and 5,900 feet of new track laid with minimal cut and fill. All roads intersected will either go under the deck truss spans or have grade crossings with automatic signals.

A-II.4. New York Central Railroad - Ontario Branch. This single track railroad will be relocated around the town of Ransomville as shown on Plate A8. The relocation will consist of a canal tunnel crossing at Lock 2 with approaches. The tunnel will be in the upper miter gate sill of Lock 2 and will include relocated Youngstown Lockport Road. There will be approximately 13,000 feet of new track in west approach, and approximately 12,100 feet of new track in the east approach, all laid on nominally level ground. All intersected roads will have grade crossings with automatic signals. There will be a 30 foot steel girder bridge span over a branch of Twelvemile Creek.

HIGHWAYS

A-II.5. Peace Bridge.

a. Existing Peace Bridge. The Peace Bridge is the only highway crossing of the Niagara River between the United States and Canada serving the city of Buffalo, and cannot be closed to traffic. The bridge consists of a through truss span across the existing Black Rock Canal, with an American approach made up of plate girder spans on a steep curved grade and a main river crossing consisting of steel arch spans with a Candian approach made up of plate girder spans on a gentle grade. It is substandard in both horizontal and vertical clearance at the proposed canal channel. It is not considered feasible to raise the steel arch spans while maintaining traffic, but if it were possible, the channel would still have substandard horizontal clearance between bridge piers. It has been assumed that plans of the Buffalo and Fort Erie Public Bridge Authority to widen the present three-lane bridge to six lanes will have been consummated before final planning on the proposed waterway begins.

b. Proposed New Peace Bridge. Layout of the proposed new bridge is shown on Plate A2 and calls for the construction of a new six-lane bridge parallel to the existing bridge, to provide adequate vertical and horizontal clearances. The new relocated bridge will consist of one 640 foot through truss span over the new channel, and four 425 foot steel arch spans over the Niagara River. The Canadian approach will be made up of three rather short steel girder spans that will tie into the existing steel girder spans east of the existing customs and truck terminal complex. The American approach will consist of eleven plate girder spans of approximately 100 feet each on a long curve. The new abutment will be located at

the south side of Busti Avenue, just north of the existing customs buildings. This approach will necessitate the removal of five small brick and wood dwelling and garage structures adjacent to Massachusetts Avenue. The existing bridge, piers and American approach will be removed after construction of the new bridge.

A-II.6. South Grand Island Bridge.

a. Existing South Grand Island Bridge. The existing bridge is actually two, practically identical, double-lane toll bridges, one northbound and one southbound carrying Interstate 190 traffic and shown on Plate A4. Each bridge consists of a 600 foot, cantilever truss main channel span plus a 300 foot and 280 foot deck truss span on each side. Each south approach is made up of fourteen plate girder spans totaling 1,100 feet with the toll facilities just south of the south abutments. Each north approach consists of eight plate girder spans totaling 523 feet. Both bridges are substandard in horizontal and vertical clearance at the proposed canal channel.

b. Proposed Revisions. The plan for revising the existing bridges calls for raising each bridge 25 feet, one at a time, in order to comply with vertical clearance requirements. The canal channel at the bridges will be reduced to 400 feet and the existing bridge piers will be protected from navigation by four circular rock fill mounds. Traffic will be maintained through temporary pavement crossovers to the bridge not being worked on. Many support piers will require remedial work consisting of additional bearing piles, pile cap area, and thickening. All support piers will have 25 feet of concrete added to their tops. New 60 foot plate girder spans will be added at each end of each bridge at the abutments.

The north embankment approach will be raised 25 feet at the new abutment, sloped uniformly to meet the existing grade. The south embankment approach will be raised 25 feet at the new abutment. The temporary and new permanent toll facilities and administration building will be located on this approach. Adjacent access road embankments will be raised. South of the new toll facilities, the embankment will slope uniformly to meet the existing grade.

A-II.7. Witmer - River Roads Connection. The layout of the Witmer-River Roads connection is shown on Plate A4. The connection will consist of two two-lane highway links, one approximately 400 feet long, between the new and existing River Roads, and one approximately 1,200 feet long, between existing River Road and Witmer Road.

A-II.8. River Road. River Road will cross the canal channel on a new high level two-lane suspension bridge located approximately 900 feet north of the existing road as shown on Plate A4. The new bridge will consist of a 1,500 foot main canal span with 750 foot anchor spans. The east approach will be made up of ten 100 foot plate girder spans and approximately 2,270 linear feet of embankment fill at a gentle slope to meet the existing grade. The west approach will consist of ten 100 foot plate girder spans and approximately 2,280 linear feet of embankment fill at a gentle slope to meet the existing grade.

A-II.9. La Salle Expressway. It is assumed that the La Salle expressway will be constructed before final planning on the new canal begins. The expressway will cross the new canal channel on a new high level four-lane suspension bridge, constructed as shown on Plate A5. The bridge will consist of a 900 foot main suspension span over the canal with 450 foot

anchor spans. The east anchor span will overpass existing Witmer Road. The east approach will be made up of six 90 foot plate girder spans, eighteen 75 foot plate girder spans, and 725 linear feet of embankment fill that will slope to intersect the existing grade. The relocated New York Central and Erie-Lackawanna Railroads will run under one of the plate girder spans. The west approach will consist of six 90 foot plate girder spans and 1,105 linear feet of embankment fill that will slope to intersect the existing grade. Traffic will be maintained during construction.

A-II.10. Niagara Falls Boulevard. Niagara Falls Boulevard will cross the canal channel on a new high level four-lane suspension bridge, located approximately 700 feet north of the existing roadway as shown on Plate A5. The new bridge will consist of a 900 foot main suspension span over the canal channel with 450 foot anchor spans. The east approach will be made up of twelve 100 foot plate girder spans and approximately 1,100 linear feet of embankment fill that slopes to meet the existing grade. The west approach will consist of seventeen 100 foot plate girder spans and approximately 700 linear feet of embankment fill that slopes to meet the existing grade.

A-II.11. Lockport Road. Lockport Road will cross the canal channel on a new high level two-lane suspension bridge on the present alignment as shown on Plate A5. The bridge will consist of a 900 foot main suspension span over the canal channel, with 450 foot anchor spans. The approaches on each side will be made up of two 100 foot plate girder spans and approximately 1,100 linear feet of embankment fill that slopes to meet the existing grade.

A-II.12. Saunders Settlement Road. Saunders Settlement Road will cross the canal channel on a new two-lane, high-level suspension bridge as shown on Plate A7. The bridge will consist of a 1,200 foot main suspension span over the canal and 600 foot anchor spans. The approaches will be made up of two 100 foot plate girder spans on each side, 100 linear feet of embankment fill on the east side, and 600 linear feet of embankment fill on the west side. The fills will slope to meet existing grades.

A-II.13. Upper Mountain Road. Upper Mountain Road will cross the canal channel on a new high-level two-lane suspension bridge as shown on Plate A7. The bridge will consist of a 900 foot main suspension span over the canal, with 450 foot anchor spans. Each approach will have three plate girder spans of 100 feet each. The east approach will have approximately 780 linear feet of embankment fill, and the west approach approximately 350 linear feet of embankment fill. The fills will slope to meet existing grades.

A-II.14. Ridge Road. Ridge Road will be relocated about 650 feet north of its present location, and will cross under the canal channel via a two-lane tunnel through the upper miter gate sill of Lock 3 as shown on Plate A7. The tunnel will be approximately 520 feet long, with concrete wing walls at each end. The western portion of the relocation will be approximately 2,600 feet of new two-lane pavement, and the eastern portion approximately 3,300 feet of new two-lane pavement between existing Ridge Road and new tunnel wing walls. The relocated road will be constructed with minimal cut and fill.

A-II.15. Youngstown-Lockport Road. As shown on Plate A8, Youngstown-Lockport Road will be relocated north of its present location, and will

cross under the canal channel via a two-lane tunnel through the upper miter gate sill of Lock 2. The tunnel will also carry the Ontario Branch Line of the New York Central Railroad. It will be approximately 500 feet long, with concrete wing walls at each end. The western portion of the relocation will be approximately 1,700 feet of new two-lane pavement between existing Youngstown-Lockport Road and tunnel wing walls. The eastern portion of the relocation will be approximately 5,000 feet of new two-lane pavement between existing Youngstown-Lockport Road and tunnel wing walls, with a grade crossing at the railroad. There will also be a two-lane extension of the relocation for approximately 2,350 feet to Pansomville Road.

A-II.16. Lake Road and Youngstown Road. Lake and Youngstown Roads will be relocated to cross under the canal channel via a common two-lane tunnel through the upper miter gate sill of Lock 1 as shown on Plate A8. The tunnel will be approximately 470 feet long, with concrete wing walls at each end. On the east side of the canal, the Lake Road branch of the relocation will be approximately 6,800 feet long between existing Lake Road and tunnel wing walls. The Youngstown Road branch will be approximately 5,500 feet long between existing Youngstown Road and relocated Lake Road. On the west side of the canal, the Lake Road branch of the relocation will be approximately 5,400 feet long between existing Lake Road and tunnel wing walls. The Youngstown Road branch will be approximately 5,100 feet long between existing Youngstown Road and relocated Lake Road. There will be a two-lane concrete bridge consisting of two 25 foot spans on both the Lake and Youngstown Road branches over Sixmile Creek.

UTILITIES

A-II.17. Gas, Oil and Water Lines. These utilities will be relocated as described below:

a. Buffalo Sewer Authority. The City of Buffalo sewer under Black Rock Canal will be abandoned, plugged, and removed as part of the relocation of the existing sewage treatment facilities, Squaw Island.

b. Iroquois Gas Corporation

(1) Two submarine gas lines of the Iroquois Gas Corporation crossing the Niagara River at the foot of Hertel Avenue in Buffalo have been abandoned.

(2) The 12 inch submarine gas line of the Iroquois Gas Corporation, crossing the Niagara River north of Grand Island Bridge, will be lowered to clear the new channel depth.

c. Lakehead Pipe Line Co. The 12 inch submarine oil line of the Lakehead Pipe Line Co., crossing the Niagara River north of Grand Island Bridge, will require no remedial work.

d. Overland Section. The gas and water lines in the Overland section of the waterway associated with River Road, Niagara Falls Boulevard, Lockport Road, Saunders Settlement Road, Upper Mountain Road, Ridge Road, and Youngstown-Lockport Road will be rerouted over or through the new bridges and tunnels. There will also be some relocation work on these utilities between River Road and Niagara Falls Boulevard.

A-II.18. Water Intakes. Water intakes along the Niagara River will be relocated as described below.

a. City of Buffalo at Porter Street. No remedial work required.

b. City of Buffalo at Peace Bridge. One of the two existing tunnels under Black Rock Canal will interfere with the new canal channel depth. This tunnel will be plugged and abandoned, and a new tunnel approximately 1,100 feet long with approximately 40 square feet of cross sectional area, will be constructed at a lower elevation. The existing wells at the intake pier and pump station will be lowered.

c. Cities of Tonawanda and North Tonawanda. The two existing 48 inch wood stave pipelines under the Niagara River will interfere with the new channel depth, and the existing intake piers are within the new channel confines. The pipes will be cut, plugged, and abandoned, and replaced with approximately 2,000 linear feet of new 48 inch pipe for Tonawanda and approximately 1,500 linear feet of new 48 inch pipe for North Tonawanda at a lower elevation to clear the new channel depth. New intake cribs will be constructed outside the limits of the new channel.

d. City of Lockport. The existing 48 inch wood stave pipe under the Niagara River will interfere with the new channel depth. This pipe will be cut, plugged, and abandoned, and replaced with approximately 2,300 linear feet of new 48 inch pipe at a lower elevation to clear the new channel depth. The existing intake pier is outside the limits of the new channel but will be modified for the lower pipe.

e. Town of Tonawanda. This tunnel conduit clears the new channel depth and no remedial work is required.

A-II.19. Electric Power and Communications. Electric power and communications lines that cross the Niagara River and Overland section of the proposed waterway will be relocated as described below.

a. Niagara Mohawk Power Co.

(1) The Niagara River aerial crossing of the Niagara Mohawk Power Co., just north of the Peace Bridge, is above the established minimum vertical clearance. No remedial work is required.

(2) Just north of the Grand Island Bridge there is an overhead 69 kva power line and two armored submarine cables of the Niagara Mohawk Power Co., crossing the Niagara River. Both are substandard regarding new channel clearance. Service on the overhead lines will be temporarily discontinued, lines removed, existing towers raised approximately 5 feet, and new lines installed. During service interruption, power will be supplied to the affected area by alternate power sources.

b. New York Telephone Co.

(1) The existing submarine communications cable of the New York Telephone Co., crossing the Black Rock Canal alongside the Ferry Street Bridge in Buffalo, will be abandoned and adjacent poles removed.

(2) The submarine communications cable of the New York Telephone Co., crossing the Niagara River at the foot of Fix Ferry Road in Tonawanda will interfere with the new channel depth. It will be cut and abandoned, and approximately 2,100 linear feet of new cable will be laid at a lower elevation to clear the new channel depth.

c. Penn Central Railroad. The existing submarine communications cable of the Penn Central Railroad crossing the Black Rock Canal at the foot of Bird Avenue in Buffalo will be relocated in such a manner so as to move the western terminus of the crossing downstream to a new pole. From here the cable will run overhead to the new Lock 5, thence underground and through the upper miter gate sill of the lock, and thence overhead to the

existing abutment of the International Railroad Bridge to be spliced to the existing cable.

New submarine cable will be laid at a lower elevation to clear the new channel depth.

d. Overland Section. The remedial work required on the numerous facilities of the Niagara Mohawk Power Co., is not enumerated. The estimate of costs in this Appendix was furnished by the Niagara Mohawk Power Co.

e. Miscellaneous. There are several submarine communication cable crossings of the existing Black Rock Canal in the vicinity of the International Railroad Bridge. The canal and crossings in this area will not be affected by the proposed construction. However, these cables do continue across Squaw Island to the International Railroad Bridge and thus will cross new Lock 5. These crossings of the lock will be accomplished by running the cables underground and through the upper miter gate sill of the new lock and thence to the International Railroad Bridge.

A-II.20. New York State Health Department. The river stage height sensor and the submersible pumps for water sampling at the southern tip of Squaw Island will be relocated to a new site on the island because their present location will be excavated for the new channel.

A-II.21. Buffalo Sewerage System. The sewerage system for the City of Buffalo and parts of the surrounding area is operated by the Buffalo Sewer Authority. The system consists of a collection system with treatment facilities located on the south part of Squaw Island. Construction of the new canal will require that the existing treatment facilities be abandoned and new facilities and appurtenances be constructed elsewhere.

a. Existing Facilities. The existing sewage collection system is the combined type, draining toward the Niagara and Buffalo Rivers. An interceptor sewer system collects dry weather sewage flow plus a limited amount of storm water, and diverts it to the Bird Island Sewage Treatment Plant located on Squaw Island by way of an inverted siphon located near the end of Breckenridge Avenue. Treatment facilities consist of rough screening, grit removal, sedimentation, sludge digestion with incineration, and chlorination. A new 180 MGD activated sludge type secondary treatment plant addition is under construction and will consist of pumping facilities, aeration tanks with air supply and distribution facilities, final settling tanks, and chlorination facilities. The existing primary treatment facilities are being increased to 180 MGD capacity and the existing sludge handling facilities updated by the addition of sludge concentration equipment and digester mixers, and the replacement of existing vacuum filter and incineration equipment with new higher capacity equipment.

b. Relocated Sewage Treatment Plant. Proposed location for the new sewage treatment plant is along the Buffalo River at the end of Katherine Street. New sewage treatment plant and appurtenant facilities will be similar to the existing facilities at Squaw Island and will include primary and secondary treatment, chlorination and sludge digestion and disposal facilities. Design capacity will be 180 MGD with provisions for expansion to 240 MGD.

c. New Interceptor Sewer and Pumping Facilities. A new 9.0 foot diameter interceptor sewer would be required to transmit the sewage from the inverted siphon to the new plant. New pumping facilities at the plant would lift the raw sewage from the interceptor to the treatment plant. The

new interceptor sewer and the pumping facilities would have a peak design capacity of 565 MGD. The interceptor sewer would be constructed by tunneling and would be approximately 5.25 miles long.

A-II.22. Incinerator - City of Buffalo. The City of Buffalo incinerator located on Squaw Island will not be affected by the new channel; however, the associated fly ash lagoons will have to be relocated.

A-II.23. Niagara River Compensating Excavation. The proposed new wider channel upstream of Lock 5 will require that Bird Island Pier be relocated westward of its present location and thus restrict the Niagara River in this vicinity. In order to maintain the existing Lake Erie stage - Niagara River discharge relation, compensating excavation above Elevation 554.0 IGLD will be required in the Niagara River. This excavation will be required for approximately 6,000 feet from the mouth of the Niagara River, downstream to a point north of the Peace Bridge and will be approximately 274,500 cubic yards.

SECTION III - PROPERTY

A-III.1. Real Estate Acquisition. The estimated cost for real estate is based upon assessed valuations of affected parcels of land, adjusted to current market value by applying factors based upon ratio of recent sales to assessed valuations. The estimate includes allowances for acquisition, relocation costs and contingencies. The right-of-way needed for the canal was laid out on large scale current maps. The right-of-way included the canal proper, relocations and surge basins. By use of current tax maps, the right-of-way line was then adjusted to fit parcel lines where necessary, on the basis of judgments as to whether a remaining portion would possess any significant value. Where it appeared there would be little or no residual value, the entire parcel was included in the right-of-way. Once parcel boundaries were established, the assessed value for each parcel was obtained from the assessor's office for each political subdivision. Then the value of recent sales for representative types of property were obtained for property in each political subdivision. Next, the ratio of sale value to assessed value was determined. Then this ratio was applied to the assessed value of parcels of similar nature; i.e., residential, agricultural, industrial, etc. The new values for all parcels in each subdivision, based on the recent sales, was then tabulated. It was assumed that in all cases, fee title would be acquired. Since almost all the right-of-way would be occupied by permanent improvements, no consideration was given to acquisition of a lesser interest. Also included in the estimate are allowances for acquisition and relocation, and also contingency. Acquisition costs and relocation costs were based on standard allowance used on recent Corps projects. Finally, a contingency amount of about 20 percent was added to all items.

SECTION IV - ESTIMATES OF COST

A-IV.1. Basis of Estimates.

a. Procedures. All construction costs and interest rates are based on prevailing levels as of December 1972. The assumed Federal interest rate for interest during construction and debt amortization, established by the Corps of Engineers, is 5-5/8 percent. Cost estimates developed during earlier phases of the work were escalated by the use of Engineering News Record Construction Cost Index ratios. In general, the amount of detail in the estimate is consistent with the detail of the design for a particular item or group of related cost items. Where insufficient data or time did not permit detailed design of individual features of the canal or locks, lump sum prices or unit prices and quantities were adapted from bid abstracts of similar projects. This method was particularly useful in developing the detailed lock estimates, where many of the lump sum prices were obtained by escalating modified prices from the St. Marys Falls Canal, Poe Lock abstract of bids. Unit prices for excavation and dredging of rock, shale, and overburden materials were developed by consultation with contractors and the Buffalo District, in conjunction with an evaluation of the type of construction procedures and methods that would be suitable and/or necessary for a project of this magnitude. These unit prices include excavation, loading, hauling, and unloading. The cost of any additional handling, processing, spreading, or compaction are covered as separate items or included in the unit costs of other items.

b. Period of Construction. The period of construction has been assumed as five years. This is the same construction period proposed in a report by the Buffalo District, Corps of Engineers, titled "Feasibility Study for Review of Reports of Great Lakes and Connecting Waters with Reference to a Lake Erie-Lake Ontario Waterway," dated December 1961. A five year construction period will require a high degree of coordination and careful scheduling for the work on the locks, harbor, channels, dikes, and appurtenances to be completed during that period.

c. Estimated Annual Costs. Engineering and design at 3 percent, plus supervision and administration at 8 percent have been added to the total construction cost to obtain the total project first cost. The percentages for engineering and design and supervision and administration include overhead. The construction period of five years requires that interest at 5-5/8 percent for two and one-half years (one half the construction period) be added to the total project first cost to obtain the total investment cost. Annual charges on the investment cost were computed by applying the 5-5/8 percent interest rate and amortizing the cost over 50 years at the same interest rate. To this estimated annual operation and maintenance charges were added to obtain the total estimated annual cost.

A-IV.2. Summary of Estimated Costs. The summary of estimated cost is contained in Table A 7 below.

TABLE A 7 - SUMMARY OF ESTIMATED COSTS
(Based on 12-72 Price Levels)

Item	Amount
LANDS AND DAMAGES	$ 25,000,000
RELOCATIONS	582,000,000
LOCKS	690,000,000
CHANNELS AND CANALS	529,000,000
RECREATION FACILITIES	10,000,000
LAKE ONTARIO HARBOR	163,000,000
OPERATION AND MAINTENANCE FACILITIES	16,800,000
TOTAL CONSTRUCTION COST	$2,015,800,000
ENGINEERING AND DESIGN	60,500,000
SUPERVISION AND ADMINISTRATION	161,300,000
TOTAL PROJECT COST	$2,237,600,000

A-IV.3. Details of Estimated Costs. The details of estimated costs are contained in Table A 8 below:

TABLE A 8 - DETAILS OF ESTIMATED COSTS
(Based on 12-72 Price Levels)

Item	Unit	Unit Quantity	Cost	Amount
LANDS AND DAMAGES				
Land Fee Title				$ 9,330,000
Improvements				8,200,000
Acquisition Costs				1,620,000
Relocation Allowances				1,900,000
Contingencies				3,950,000
TOTAL - LANDS AND DAMAGES				$25,000,000

Item	Unit	Unit Quantity	Cost	Amount
RELOCATIONS				
Railroads				
International RR Bridge	lump sum			$ 6,300,000
Erie-Lackawana RR	lump sum			29,400,000
NYC RR - Niagara & Falls Rd. Br.	lump sum			40,500,000
NYC RR - Ontario Branch	lump sum			1,550,000
Contingencies				11,250,000
Subtotals - Railroads				$89,000,000
Highways				
Peace Bridge	lump sum			$ 30,200,000
South Grand Island Br.	lump sum			15,500,000
Witmer-River Roads Conn.	lump sum			39,000
River Road	lump sum			21,300,000
LaSalle Expressway	lump sum			29,100,000
Niagara Falls Blvd.	lump sum			25,800,000
Lockport Road	lump sum			9,120,000
Saunders Settlement Rd.	lump sum			13,500,000
Upper Mountain Rd.	lump sum			9,030,000
Ridge Road	lump sum			2,580,000
Youngstown-Lockport Rd.	lump sum			2,650,000
Lake Road-Youngstown Rd.	lump sum			3,840,000
Contingencies				24,341,000
Subtotal Highways				$187,000,000
Squaw Island Waste Treatment Plant				
Treatment Facilities Relocation	lump sum			$200,000,000
Pumping Facilities & Trans. Main	lump sum			50,000,000
Contingencies				38,000,000
Subtotal - Treatment Plant Relocation				$288,000,000
Utilities				
Gas and Water Lines				
Niagara River - North of Grand Island Bridge	lump sum			$ 400,000
River Road - Niagara Falls Blvd.	lump sum			85,000
River Road	lump sum			238,000
Niagara Falls Blvd.	lump sum			406,000
Lockport Road	lump sum			292,000
Saunders Settlement Rd.	lump sum			61,200
Upper Mountain Road	lump sum			374,000
Ridge Road	lump sum			74,800
Youngstown - Lock Roads	lump sum			76,500
Contingencies				292,500
Subtotal - Gas and Water Lines				$ 2,300,000

Item	Unit	Unit Quantity	Cost	Amount
Water Intakes				
City of Buffalo	lump sum			$ 510,000
City of Tonawanda	lump sum			1,530,000
City of North Tonawanda	lump sum			1,160,000
City of Lockport	lump sum			1,840,000
Contingencies				760,000
Subtotal - Water Intakes				$5,800,000
Electric Power and Communications				
Niagara River - Ferry St.	lump sum			$ 500
Niagara River - Bird Ave.	lump sum			11,000
Niagara River - Fix Ferry Rd.	lump sum			83,400
Niagara River - North of Grand Island Br.	lump sum			500,000
Overland Section	lump sum			8,000,000
Contingencies				1,301,600
Subtotal - Electric Power and Communications				$9,896,500
Miscellaneous				
Stage Height and Water Sampling Station at Ferry St. Br. - Buffalo	lump sum			$ 3,000
Contingencies				500
Subtotal - Miscellaneous				$ 3,500
TOTAL - RELOCATIONS				$582,000,000

Item	Unit	Unit Quantity	Cost	Amount
LOCKS				
Lock 1				
Unclassified Excavation	cu yd	1,631,000	1.50	$ 2,446,500
Rock Excavation	cu yd	2,934,000	8.50	24,939,000
Backfill - Random	cu yd	2,665,000	0.25	666,250
Backfill - Rock	cu yd	100,000	0.15	15,000
Concrete - Mass	cu yd	1,535,000	55.00	84,425,000
Reinforcements	lbs	6,140,000	0.30	1,842,000
Wall Armor and Corner Project.	lump sum			1,040,000
Timber Fenders	lin ft	4,200	46.00	193,200
Miter Gate No. 1 - Upper	lump sum			624,000
Miter Gate No. 2 - Intermediate	lump sum			2,340,000
Miter Gate No. 3 - Lower	lump sum			2,340,000
Miter Gate No. 4 - Dewatering	lump sum			642,000
Miter Gates-Embedded Metals	lump sum			338,000
Tainter Valves	lump sum			515,000
Tainter Valves-Embedded Metals	lump sum			134,500
Lock Bulkheads Incl. Pickup Bm.	lump sum			790,000
Lock Bulkheads-Embedded Metals	lump sum			80,400
Wire Rope Fenders	lump sum			1,714,000
Floating Mooring Bitts	lump sum	16	15,500	248,000
Snubbing Buttons	lump sum	183	290	53,100
Culvert Intake Trash Racks	lump sum			78,300
Stiffleg Derrick and Hoist Machinery	lump sum			308,000
Elevator	lump sum			51,500
Miscellaneous Metal	lump sum			317,000
Miscellaneous Frames and Covers	lump sum			163,000
Culvert Bulkheads and Embedded Met.	lump sum			154,000
Compressed Air System	lump sum			75,500
Steam and Fuel on System	lump sum			341,000
Water System	lump sum			61,000
Backfill Drainage	lump sum			46,600
Miter Gates Operating Machinery	lump sum			783,000
Culvert Valves Operating Machinery	lump sum			665,000
Embedded and Underground Elec. Cond.	lump sum			287,000
Power Control and Lighting	lump sum			1,700,000
Dewatering System Including Pumps	lump sum			232,000
Foundation Drilling and Grouting	lump sum			910,000
Cofferdam	lump sum			1,360,000
Access Roads	lump sum			244,000
Seeding and Landscaping	lump sum			44,000
Interior Lock Drainage	lump sum			69,000
Control Houses	ea	2	84,000	168,000
Operating Building	ea	1	76,000	76,000
Esplanade Including Observation Building	lump sum			582,000
Sanitary Sewage Disp.	lump sum			40,000
Unlisted Items	lump sum			13,434,000
Contingencies				14,334,150
Subtotal Lock 1				$162,000,000

Item	Unit	Unit Quantity	Cost	Amount
Lock 2				
Unclassified Excavation	cu yd	2,991,000	1.50	$ 4,486,500
Rock Excavation	cu yd	367,000	8.50	3,119,500
Backfill - Random	cu yd	4,409,000	0.25	1,102,250
Backfill - Rock	cu yd	1,890,000	0.15	283,500
Concrete - Mass	cu yd	1,673,000	55.00	92,015,000
Reinforcement	lbs	6,692,000	0.30	2,007,600
Wall Armor and Corner Protect.	lump sum			1,040,000
Timber Fenders	lin ft	4,200	46.00	193,200
Miter Gate No. 1 - Upper	lump sum			624,000
Miter Gate No. 2 - Intermediate	lump sum			2,340,000
Miter Gate No. 3 - Lower	lump sum			2,340,000
Miter Gate No. 4 - Dewatering	lump sum			642,000
Miter Gates-Embedded Metals	lump sum			338,000
Tainter Valves	lump sum			515,000
Tainter Valves-Embedded Metals	lump sum			134,500
Lock Bulkheads Incl. Pickup Bm.	lump sum			691,000
Lock Bulkheads-Embedded Metals	lump sum			71,500
Wire Rope Fenders	lump sum			1,714,000
Floating Mooring Bitts	ea.	16	15,500	248,000
Snubbing Buttons	ea.	183	290	53,100
Culvert Intake Trash Racks	lump sum			94,300
Stiffleg Derrick and Hoist Machinery	lump sum			308,000
Elevator	lump sum			51,500
Miscellaneous Metal	lump sum			317,000
Miscellaneous Frames and Covers	lump sum			163,000
Culvert Bulkheads and Embedded Metals	lump sum			254,000
Compressed Air System	lump sum			75,000
Steam and Fuel Oil System	lump sum			341,000
Water System	lump sum			61,000
Backfill Drainage	lump sum			46,600
Miter Gates Operating Mach.	lump sum			783,000
Culvert Valves Operating Mach.	lump sum			665,000
Embedded and Underground Elec. Cond.	lump sum			287,000
Power Control and Lighting	lump sum			1,700,000
Dewatering System Incl. Pumps	lump sum			232,000
Foundation Drilling and Grouting	lump sum			910,000
Access Roads	lump sum			609,000
Seeding and Landscaping	lump sum			44,000
Interior Lock Drainage	lump sum			69,000
Control Houses	ea.	2	84,000	168,000
Operations Buildings	ea.	6.2	76,000	76,000
Esplanade-Incl. Observ. Bldg.	lump sum			582,000
Sanitary Sewage Disposal	lump sum			40,000
Unlisted Items	lump sum			12,184,000
Contingencies				12,980,450
Subtotal Lock 2				$147,000,000

Item	Unit	Unit Quantity	Cost	Amount
Lock 3				
Unclassified Excavation	cu yd	664,000	1.50	$ 996,000
Rock Excavation	cu yd	357,000	8.50	3,034,500
Backfill - Random	cu yd	5,313,000	0.25	1,328,250
Backfill - Rock	cu yd	2,460,000	0.15	369,000
Concrete - Mass	cu yd	1,837,000	55.00	101,035,000
Reinforcement	lbs	7,348,000	0.30	2,204,000
Wall Armor and Corner Protect.	lump sum			1,040,000
Timber Fenders	lin ft	4,200	46.00	193,200
Miter Gate No. 1 - Upper	lump sum			624,000
Miter Gate No. 2 - Intermediate	lump sum			2,340,000
Miter Gate No. 3 - Lower	lump sum			2,340,000
Miter Gate No. 4 - Dewatering	lump sum			642,000
Miter Gates-Embedded Metals	lump sum			338,000
Tainter Valves	lump sum			515,000
Tainter Valves-Embedded Metals	lump sum			134,500
Lock Bulkheads, Incl. Pickup Bm.	lump sum			691,000
Lock Bulkheads-Embedded Metals	lump sum			71,500
Wire Rope Fenders	lump sum			1,714,000
Floating Mooring Bitts	ea	16	15,500	248,000
Snubbing Buttons	ea	183	290	53,100
Culvert Intake Trash Racks	lump sum			94,300
Stiffleg Derrick and Hoist Machinery	lump sum			308,000
Elevator	lump sum			51,000
Miscellaneous Metal	lump sum			317,000
Miscellaneous Frames and Covers	lump sum			163,000
Culvert Bulkheads and Embedded Metals	lump sum			254,000
Compressed Air System	lump sum			75,500
Steam and Fuel Oil System	lump sum			341,000
Water System	lump sum			61,000
Backfill Drainage	lump sum			46,600
Miter Gates Operating Mach.	lump sum			783,000
Culvert Valves Operating Mach.	lump sum			665,000
Embedded and Underground Elec. Cond.	lump sum			287,000
Power Control and Lighting	lump sum			1,700,000
Dewatering System Incl. Pumps	lump sum			232,000
Foundation Drilling and Grouting	lump sum			910,000
Access Roads	lump sum			868,000
Seeding and Landscaping	lump sum			44,000
Interior Lock Drainage	lump sum			69,000
Control Houses	ea	2	84,000	168,000
Operations Building	ea	1	76,000	76,000
Esplanade-Incl. Observ. Bldg.	lump sum			582,000
Sanitary Sewage Disposal	lump sum			40,000
Unlisted Items	lump sum			12,805,000
Contingencies				14,148,050
Subtotal Lock 3				$155,000,000

Item	Unit	Unit Quantity	Cost	Amount
Lock 4				
Unclassified Excavation	cu yd	804,000	1.50	$ 1,206,000
Rock Excavation	cu yd	1,468,000	8.50	12,478,000
Backfill - Random	cu yd	4,406,000	0.25	1,101,500
Backfill - Rock	cu yd	840,000	0.15	126,000
Concrete - Mass	cu yd	1,554,000	55.00	85,470,000
Reinforcement	lbs	6,216,000	0.30	1,864,800
Wall Armor and Corner Protect.	lump sum			1,040,000
Timber Fenders	lin ft	4,200	46.00	193,200
Miter Gate No. 1 - Upper	lump sum			624,000
Miter Gate No. 2 - Intermediate	lump sum			2,340,000
Miter Gate No. 3 - Lower	lump sum			2,340,000
Miter Gate No. 4 - Dewatering	lump sum			642,000
Vertical Lift Gate-Lock No. 4	lump sum			2,560,000
Miter Gates-Embedded Metals	lump sum			338,000
Tainter Valves	lump sum			515,000
Tainter Valves-Embedded Metals	lump sum			134,500
Lock Bulkheads Incl. Pickup Bm	lump sum			892,000
Lock Bulkheads-Embedded Metals	lump sum			87,500
Wire Rope Fenders	lump sum			1,714,000
Floating Mooring Bitts	ea	16	15,500	248,000
Snubbing Buttons	ea	183	290	53,100
Culvert Intake Trash Racks	lump sum			94,300
Stiffleg Derrick and Hoist Machinery	lump sum			308,000
Elevator	lump sum			51,500
Miscellaneous Metal	lump sum			317,000
Miscellaneous Frames and Covers	lump sum			163,000
Culvert Bulkheads and Embedded Metals	lump sum			254,000
Compressed Air System	lump sum			75,500
Steam and Fuel Oil System	lump sum			341,000
Water System	lump sum			61,000
Backfill Drainage	lump sum			46,600
Miter Gates Operating Mach.	lump sum			783,000
Culvert Valves Operating Mach.	lump sum			665,000
Embedded and Underground Elec. Cond.	lump sum			287,000
Power Control and Lighting	lump sum			1,700,000
Dewatering System Incl. Pumps	lump sum			232,000
Foundation Dri ling and Grouting	lump sum			910,000
Access Roads	lump sum			506,000
Seeding and Landscaping	lump sum			44,000
Interior Lock Drainage	lump sum			69,000
Control Houses	ea	2	84,000	168,000
Operations Building	ea	1	76,000	76,000
Esplanade-Incl. Observ. Bldg.	lump sum			624,000
Sanitary Sewage Disposal	lump sum			40,000
Unlisted Items	lump sum			12,378,000
Contingencies				13,838,500
Subtotal Lock 4				$150,000,000

Item	Unit	Unit Quantity	Cost	Amount
Lock 5				
Unclassified Excavation	cu yd	3,144,000	1.80	$ 5,679,000
Rock Excavation	cu yd	318,000	10.00	3,180,000
Backfill - Random	cu yd	289,000	0.50	144,500
Concrete - Mass	cu yd	626,000	55.00	34,430,000
Reinforcement	lump sum	4,000,000	0.30	1,200,000
Wall Armor and Corner Protect.	lump sum			490,000
Timber Fenders	lin ft	4,200	46.00	193,200
Miter Gate No. 1 - Upper	lump sum			710,000
Miter Gate No. 2 - Lower	lump sum			710,000
Miter Gate No. 3 - Dewater	lump sum			728,000
Miter Gates-Embedded Metals	lump sum			194,000
Tainter Valves	lump sum			155,000
Tainter Valves-Embedded Metals	lump sum			45,500
Lock Bulkheads Incl. Pickup Bm	lump sum			790,000
Lock Bulkheads-Embedded Metals	lump sum			87,800
Wire Rope Fenders	lump sum			1,290,000
Snubbing Buttons	ea	192	290	55,700
Culvert Intake Trash Racks	lump sum			11,300
Stiffleg Derrick and Hoist Machinery	lump sum			308,000
Miscellaneous Metal	lump sum			190,000
Miscellaneous Frames and Covers	lump sum			149,000
Culvert Bulkheads and Embeeded Metals	lump sum			67,500
Compressed Air System	lump sum			75,500
Steam and Fuel Oil System	lump sum			341,000
Water System	lump sum			61,000
Backfill Drainage	lump sum			23,300
Miter Gates Operating Mach.	lump sum			612,000
Culvert Valves Operating Mach.	lump sum			276,000
Embedded and Underground Elec. Cond.	lump sum			287,000
Power Control and Lighting	lump sum			1,000,000
Foundation Drilling and Grouting	lump sum			625,000
Cofferdam	lump sum			7,840,000
Access Roads	lump sum			24,000
Seeding and Landscaping	lump sum			2,300
Interior Lock Drainage	lump sum			69,000
Remove Portion of Existing Lock Guide Wall (Approx. 1100 feet)	lump sum			500,000
Control Houses	ea	2	84,000	168,000
Operations Building	ea	1	76,000	76,000
Esplanade	lump sum			118,000
Sanitary Sewage Disposal	lump sum			40,000
Unlisted Items	lump sum			6,295,000
Contingencies	lump sum			6,758,400
Subtotal Lock 5				$76,000,000
TOTAL-LOCKS				690,000,000

Item	Unit	Unit Quantity	Cost	Amount
CHANNELS AND CANALS				
Diversion and Care of Water	lump sum			$ 1,852,500
Clearing	acres	3,100	$ 300.00	930,000
Demolition				
Ferry Street Bridge	lump sum			100,000
Sheet Piling-Squaw Island	lump sum			500,000
Earth Excavation				
Niagara River Above Lock 5	cu yd	4,743,000	3.00	14,229,000
Niagara River Below Lock 5	cu yd	11,329,000	3.00	33,987,000
Overland Section	cu yd	31,358,000	1.50	47,037,000
Lake Ontario Harbor	cu yd	194,000	3.00	582,000
Rock Excavation				
Niagara River Above Lock 5	cu yd	4,781,000	15.00	71,715,000
Niagara River Below Lock 5	cu yd	3,335,000	10.00	22,240,000
Overland Section	cu yd	41,457,000	6.00	248,742,000
Lake Ontario Harbor	cu yd	933,000	10.00	9,330,000
Dikes				
Earth Embankment Core	cu yd	4,787,000	0.25	1,196,750
Rock or Shale Embankment	cu yd	44,228,000	0.15	6,634,200
Disposal				
Dikes	cu yd	10,315,000	0.15	1,547,250
Bird Island Pier				
Sheet Piling	tons	8,000	350.00	2,800,000
Concrete Cap	cu yd	16,000	50.00	800,000
Rock Fill	cu yd	150,000	3.00	450,000
Sheet Pile Retaining Wall	tons	1,600	450.00	720,000
5' diameter by 110' long Surge Culverts	ea	400	5,000.00	2,000,000
Rock Protection Channel Side Slopes	sq yd	431,000	5.00	2,155,000
Seeding and Landscaping Channel Side Slopes	acres	70	800.00	56,000
Overland Section Temporary Control Structure	lump sum			75,000
Contingencies				48,211,300
TOTAL - CHANNELS AND CANALS				$529,000,000

Item	Unit	Unit Quantity	Cost	Amount
RECREATION FACILITIES				
Canal Parkway	lump sum			$ 2,000,000
Visitor Center	lump sum			2,000,000
Public Recreation Facilities	lump sum			6,000,000
TOTAL - RECREATION				$10,000,000

Item	Unit	Unit Quantity	Cost	Amount
LAKE ONTARIO HARBOR				
Earth Excavation	cu yd	2,300,000	3.00	$ 6,900,000
Rock Excavation	cu yd	8,600,000	10.00	86,000,000
Breakwaters				
Core Stone	ton	6,300,000	3.00	18,900,000
Secondary Armor Stone	ton	1,520,000	8.50	12,920,000
Primary Armor Stone	ton	1,645,000	14.50	23,852,500
Contingency	lump sum			14,427,500
TOTAL - LAKE ONTARIO HARBOR				$163,000,000

Item	Unit	Unit Quantity	Cost	Amount
OPERATION AND MAINTENANCE FACILITIES				
Maintenance and Warehouse Bldg.	lump sum			$ 3,000,000
Administration Bldg.	lump sum			1,650,000
Maintenance Mooring Basin	lump sum			3,400,000
Floating Maintenance Equipment	lump sum			6,000,000
Land Maintenance Equipment	lump sum			550,000
Contingencies				2,200,000
TOTAL - OPERATION AND MAINTENANCE FACILITIES				$16,800,000

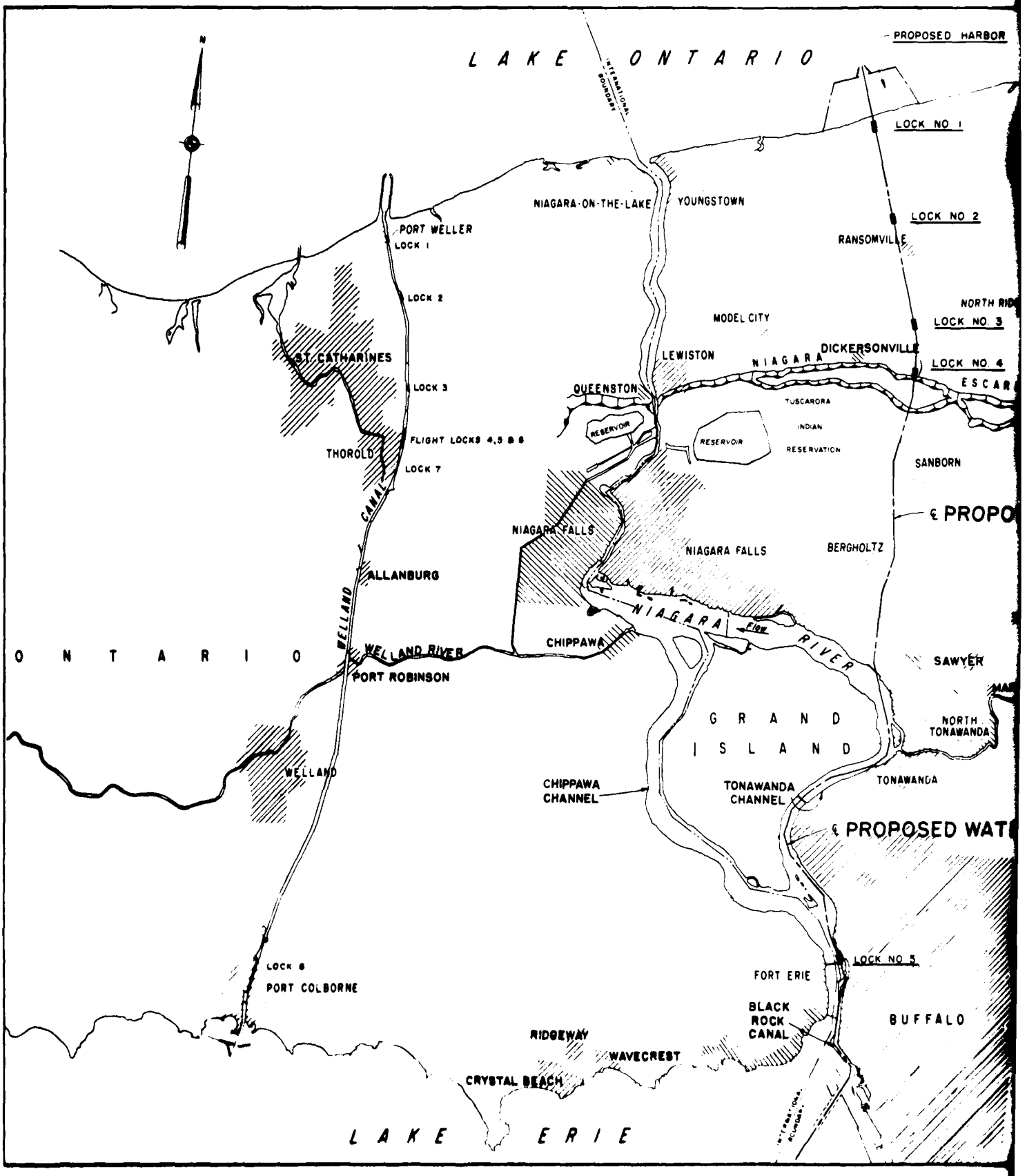
A-IV.4. Estimate of Annual Costs. The estimate of annual costs is as shown below.

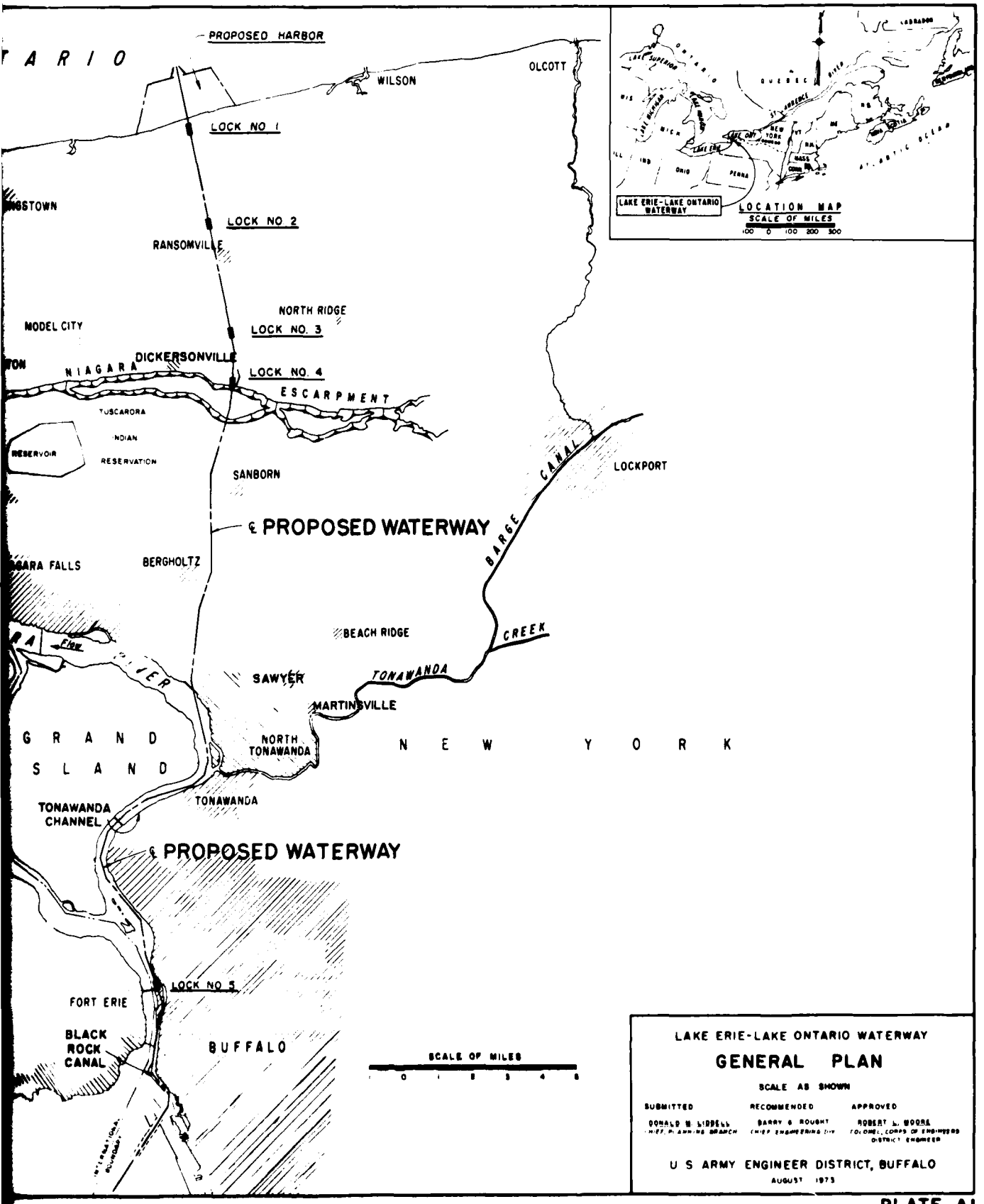
ESTIMATE OF ANNUAL COSTS

Total Project First Cost	$2,237,600,000
Interest During Construction	
$2,237,600,000 X 5/2 X .05625	314,662,500
Total Investment Costs	$2,552,262,500
Annual Charges	
Interest $2,552,262,500 X .05625	$ 143,564,766
Amortization $2,552,262,500 X .0039	9,953,824
Operation and Maintenance	20,000,000
TOTAL - ANNUAL COSTS	$ 173,518,590

A-IV.5. Estimate of Separable Costs for Recreation. Since there are no other alternative projects to the proposed canal, the separable costs for recreation are $10,000,000, as contained in Table A8, Summary of Estimated Costs, "Recreation Facilities."

A-IV.6. Cost Allocation. All costs for the project are allocated to navigation with an incremental cost to recreation.


LAKE ONTARIO
INTERNATIONAL BOUNDARY
PROPOSED HARBOR
LOCK NO 1
LOCK NO 2
LOCK NO. 3
LOCK NO. 4
NIAGARA-ON-THE-LAKE
YOUNGSTOWN
RANSOMVILLE
PORT WELLER
LOCK 1
LOCK 2
LOCK 3
FLIGHT LOCKS 4,5 & 6
LOCK 7
THOROLD
ST. CATHARINES
MODEL CITY
LEWISTON
DICKERSONVILLE
NIAGARA
QUEENSTON
TUSCARORA INDIAN RESERVATION
RESERVOIR
RESERVOIR
SANBORN
ESCAR
PROPO
NIAGARA FALLS
NIAGARA FALLS
BERGHOLTZ
WELLAND CANAL
ALLANBURG
NIAGARA RIVER
Falls
CHIPPAWA
WELLAND RIVER
PORT ROBINSON
ONTARIO
SAWYER
GRAND ISLAND
NORTH TONAWANDA
WELLAND
CHIPPAWA CHANNEL
TONAWANDA CHANNEL
TONAWANDA
PROPOSED WAT
LOCK 8
PORT COLBORNE
FORT ERIE
LOCK NO 5
BLACK ROCK CANAL
BUFFALO
RIDGEWAY
WAVECREST
CRYSTAL BEACH
LAKE ERIE
INTERNATIONAL BOUNDARY



LAKE ERIE-LAKE ONTARIO WATERWAY

GENERAL PLAN

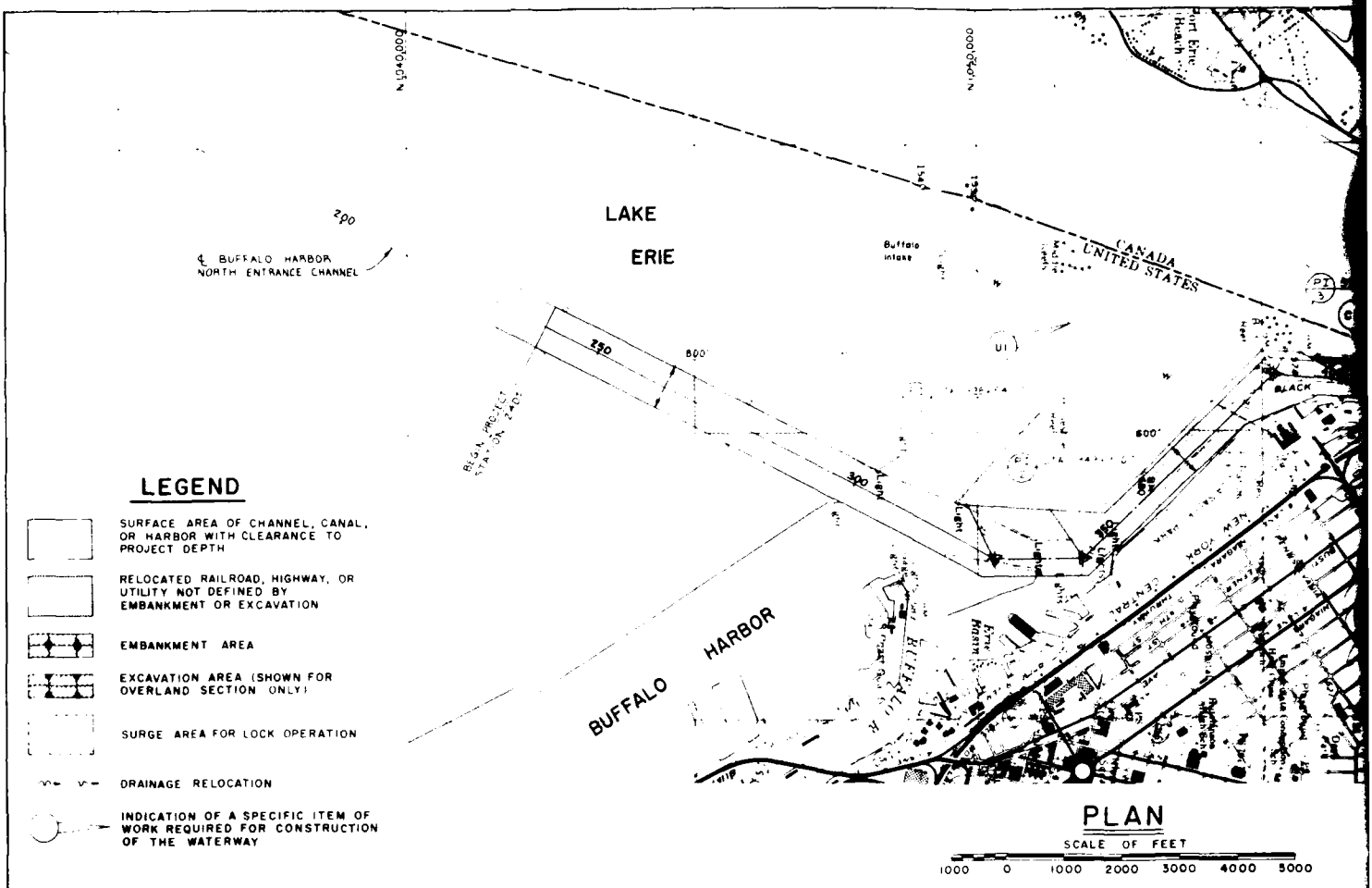
SCALE AS SHOWN

SUBMITTED	RECOMMENDED	APPROVED
DONALD M. LIBBELL, CHIEF, PLANNING BRANCH	BARRY G. ROUGHT, CHIEF ENGINEERING DIV.	ROBERT L. MOORE, COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

U S ARMY ENGINEER DISTRICT, BUFFALO

AUGUST 1973

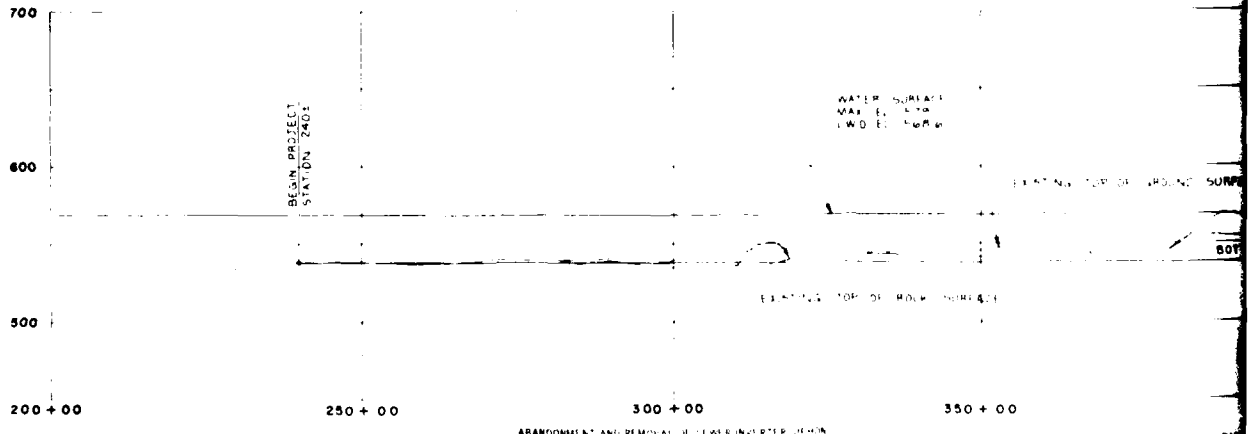
PLATE A1



PLAN

SCALE OF FEET

1000 0 1000 2000 3000 4000 5000



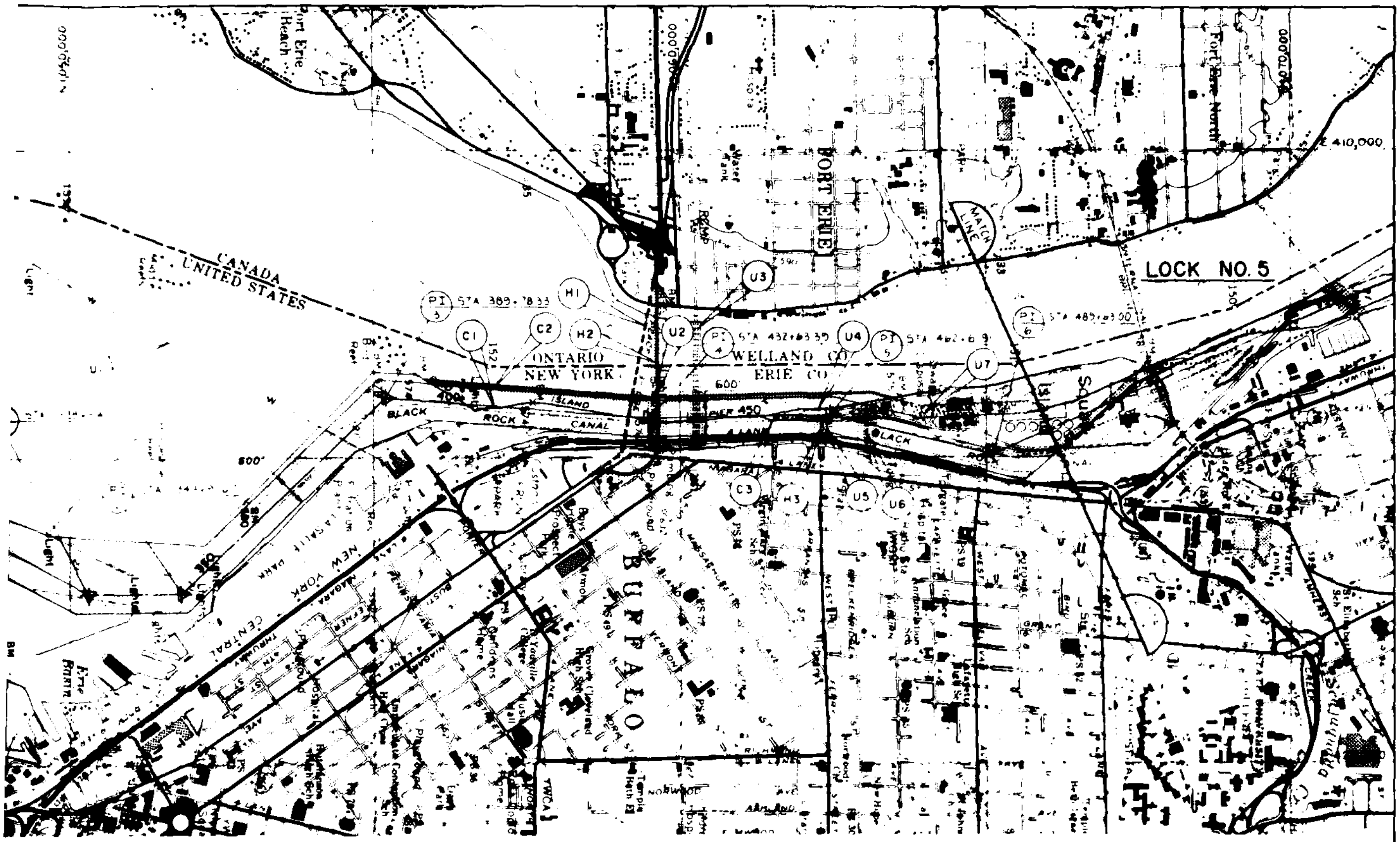
PROFILE

UTILITIES

- U1 WATER INTAKE TO REMAIN NO ALTERATIONS REQUIRED
- U2 REPLACEMENT OF CITY OF BUFFALO AUXILIARY WATER INTAKE TUNNEL WITH NEW TUNNEL AT REQUIRED DEPTH
- U3 NIAGARA MOHAWK POWER CO. AERIAL CROSSING TO REMAIN NO ALTERATIONS REQUIRED
- U4 RELOCATION OF NEW YORK STATE DEPARTMENT OF HEALTH GAGING AND SAMPLING STATION
- U5 ABANDONMENT AND REMOVAL OF NEW YORK TELEPHONE CABLE TO BUFFALO SEWAGE TREATMENT PLANT
- U6 ABANDONMENT AND REMOVAL OF SEWER INVERTED SIPHON TO BUFFALO SEWAGE TREATMENT PLANT
- U7 REMOVAL OF BUFFALO SEWAGE TREATMENT PLANT OUTFALL SQUAW ISLAND

HIGHWAYS

- H1 REMOVAL OF PEACE BRIDGE
- H2 NEW PEACE BRIDGE
- H3 REMOVAL OF FERRY STREET BRIDGE



PLAN

SCALE OF FEET

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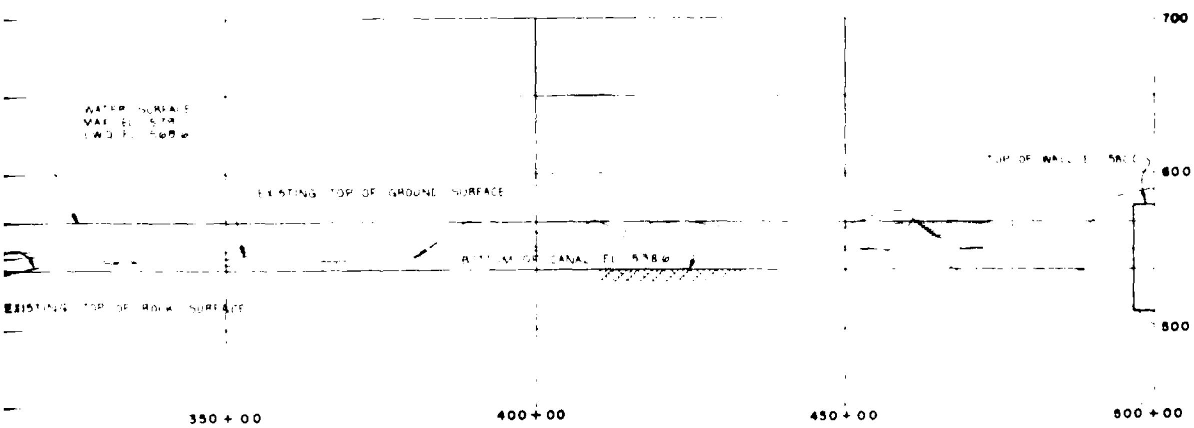


PROFILE

CHANNEL IMPROVEMENTS

C1 [illegible] AND PIER LOCATED [illegible] LIMITS

C2 [illegible] DREDGING [illegible] FOR LOSS OF CROSS [illegible] AREA

(C3) [illegible] AROUND [illegible] INSIDE CHANNEL [illegible]

LAKE ERIE-LAKE ONTARIO WATERWAY

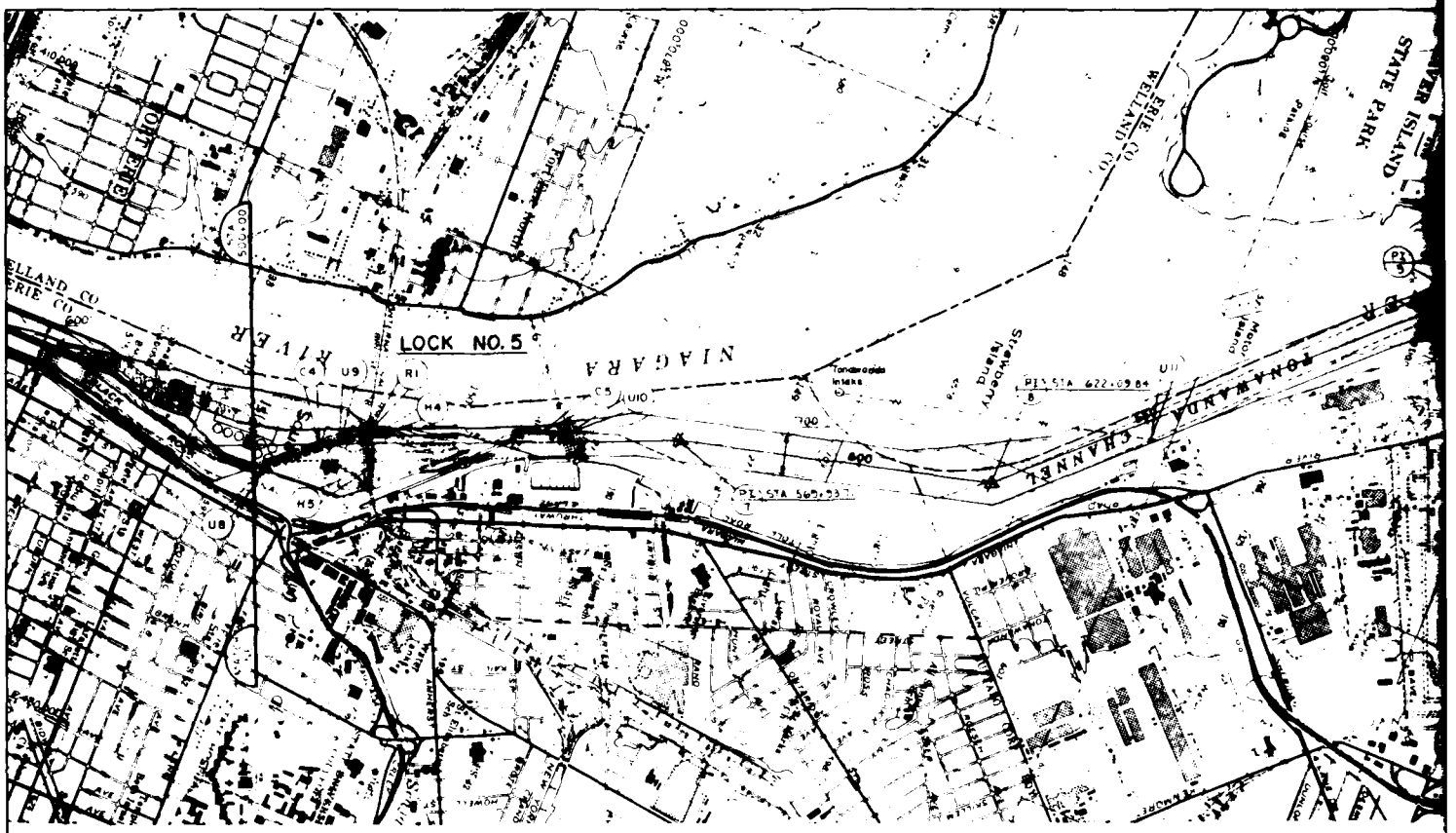
PLAN AND PROFILE

STA. 240+00 to 500+00

SCALE AS SHOWN

U S ARMY ENGINEER DISTRICT, BUFFALO

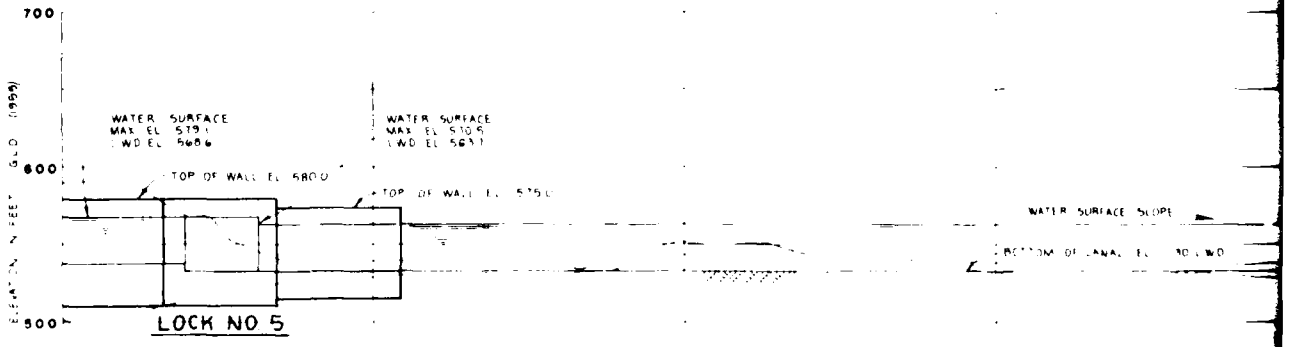
PLATE A2



PLAN

SCALE OF FEET

1000 0 1000 2000 3000 4000 5000



PROFILE

UTILITIES

- (U8) REPLACEMENT OF PENN CENTRAL RAILROAD COMMUNICATION LINES WITH LINES OUTSIDE CHANNEL LIMITS (PORTION THROUGH LOCK NO. 5)
- (U9) RELOCATION OF BUFFALO INCINERATOR FLYASH LAGOONS
- (U10) REMOVAL OF ABANDONED IROQUOIS GAS CORPORATION LINE INSIDE CHANNEL LIMITS
- (U11) *WATER INTAKE TO REMAIN - NO ALTERATIONS REQUIRED*
- (U12) REPLACEMENT OF NEW YORK TELEPHONE CO. SUBMARINE CABLE WITH NEW CABLE AT REQUIRED DEPTH

HIGHWAYS

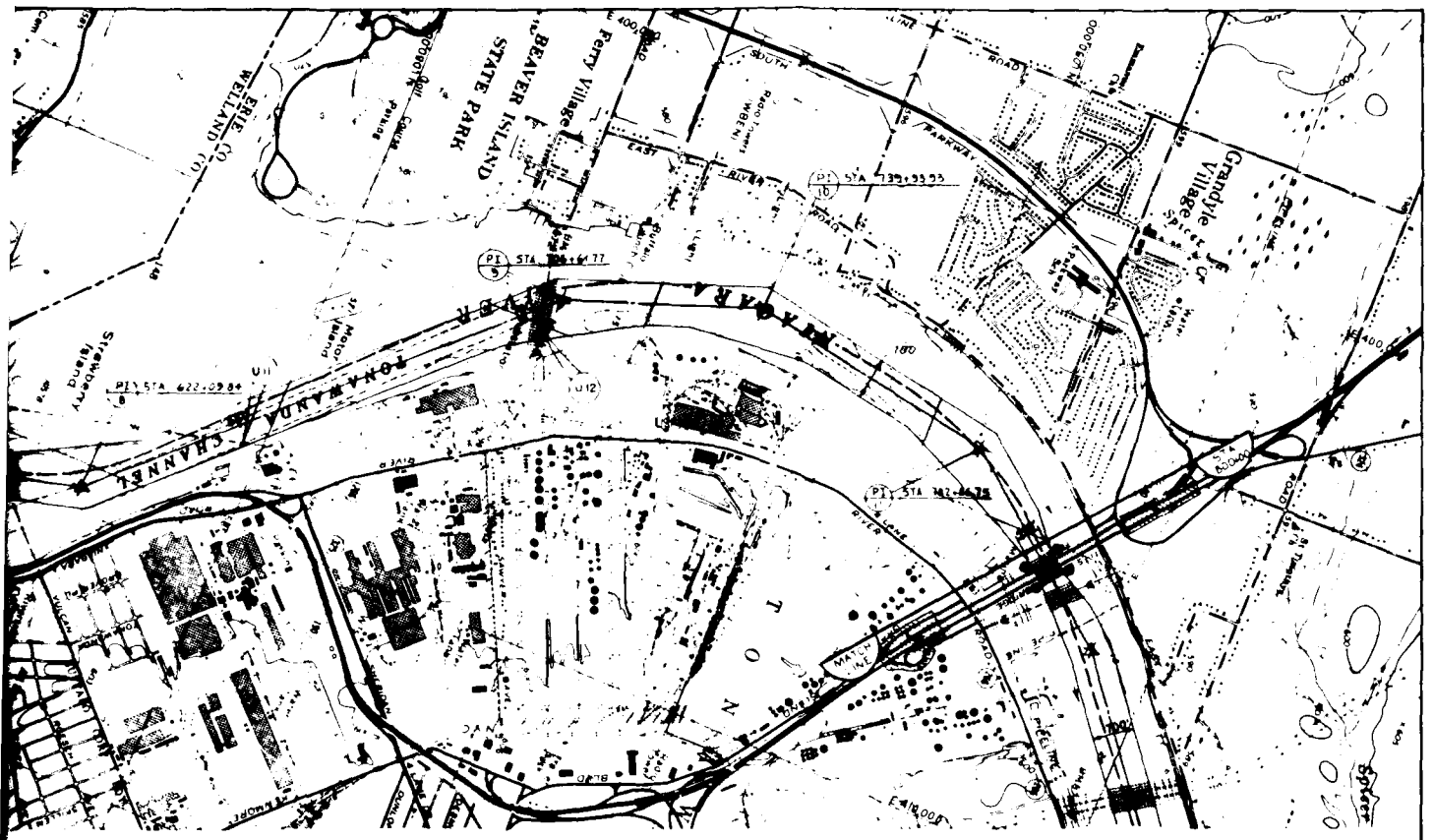
- H4 RELOCATED ACCESS HIGHWAY TO PORTION OF SQUAW ISLAND ON NEW BASCULE RAILROAD BRIDGE
- H5 NEW ACCESS ROAD TO LOCK NO. 5

RAILROADS

- R1 NEW BASCULE RAILROAD BRIDGE LOCATED ON WALLS OF LOCK NO. 5

CHANNEL

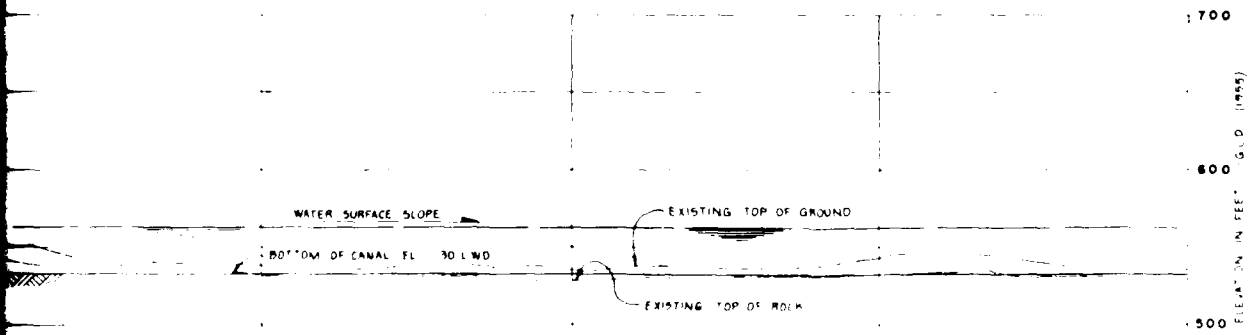
- C4 INSTALLATION
- C5 REMOVAL OF INSIDE CHANNEL



PLAN

SCALE OF FEET

1000 0 1000 2000 3000 4000 5000



650+00 700+00 750+00 800+00

PROFILE

CHANNEL IMPROVEMENTS

C4 INSTALLATION OF SHEET PILE RETAINING WALL

C5 REMOVAL OF PORTION OF BLACK ROCK LOCK LOCATED INSIDE CHANNEL LIMITS

LAKE ERIE-LAKE ONTARIO WATERWAY

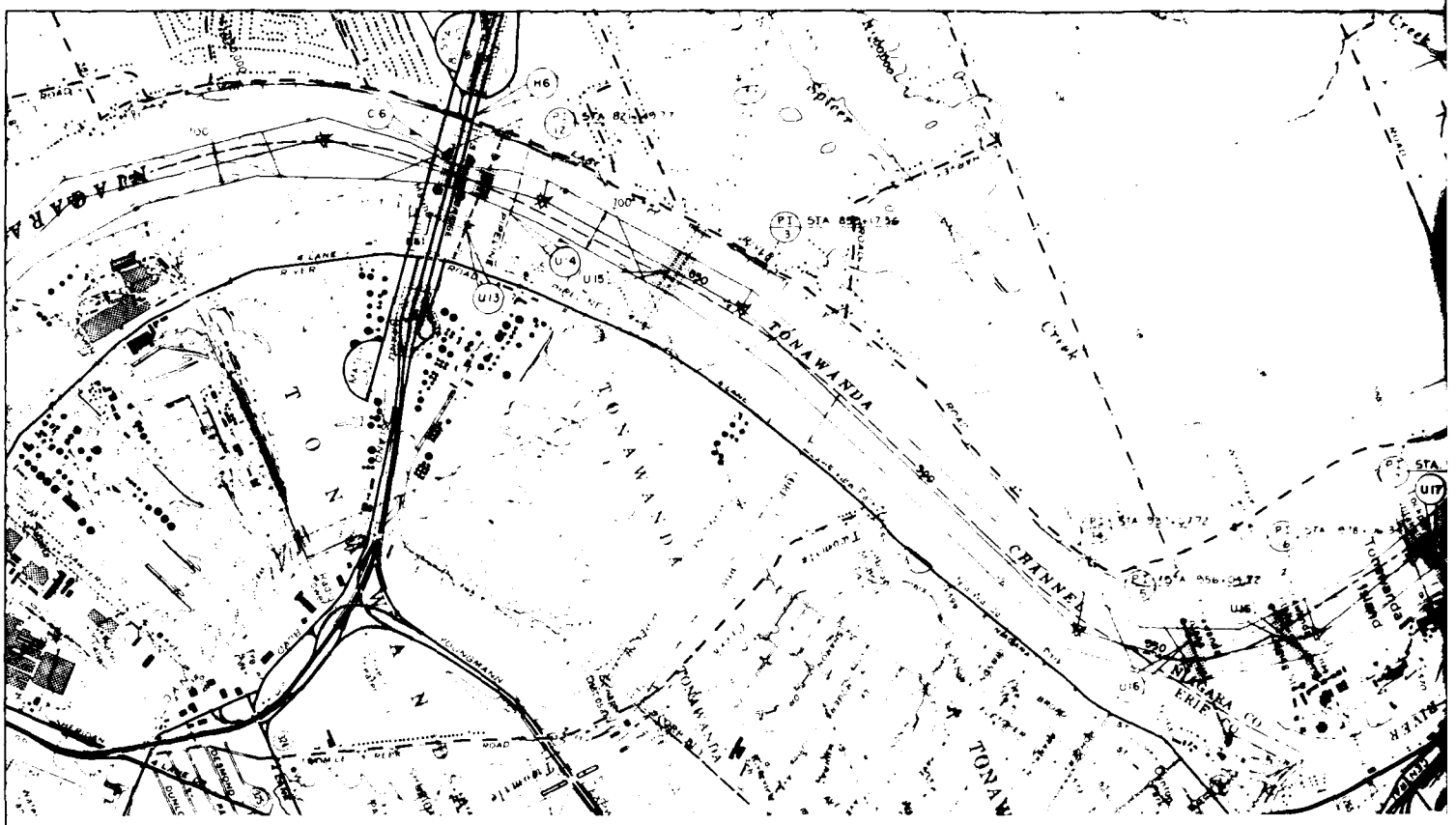
PLAN AND PROFILE

STA. 500+00 to 800+00

SCALE AS SHOWN

U S ARMY ENGINEER DISTRICT, BUFFALO

PLATE A3



PLAN

SCALE OF FEET

1000 0 1000 2000 3000 4000 5000

PROFILE

UTILITIES

U13	REPLACEMENT OF IROQUOIS GAS LINE WITH NEW LINE AT REQUIRED DEPTH
U14	LAKEHEAD PIPE LINE CO. CROSSING TO REMAIN. NO ALTERATIONS REQUIRED
U15	RAISING OF NIAGARA MOHAWK POWER CO. OVERHEAD LINES AND REPLACEMENT OF SUBMARINE CABLES WITH NEW CABLES AT REQUIRED DEPTH
U16	REPLACEMENT OF WATER INTAKE WITH NEW INTAKE CRIB OUTBOARD OF SIDE CHANNEL LIMITS AND NEW INTAKE PIPE AT REQUIRED DEPTH
U17	REPLACEMENT OF WATER INTAKE PIPE WITH NEW PIPE AT REQUIRED DEPTH

HIGHWAYS

H6	RAISING OF [illegible] GRAND ISLAND BRIDGE AND APPROACHES
H7	ABANDON ROAD
H8	NEW WITMER ROAD - RIVER ROAD CONNECTION

RAILROADS

R2	NEW RAILROAD GRADE CROSSING

PLAN

SCALE OF FEET

1000 0 1000 2000 3000 4000 5000

700

600

500

950+00

1000+00

1100+00

CHANNEL IMPROVEMENTS

PROFILE

NIAGARA FRONTIER AND LAKE ONTARIO WATERWAY

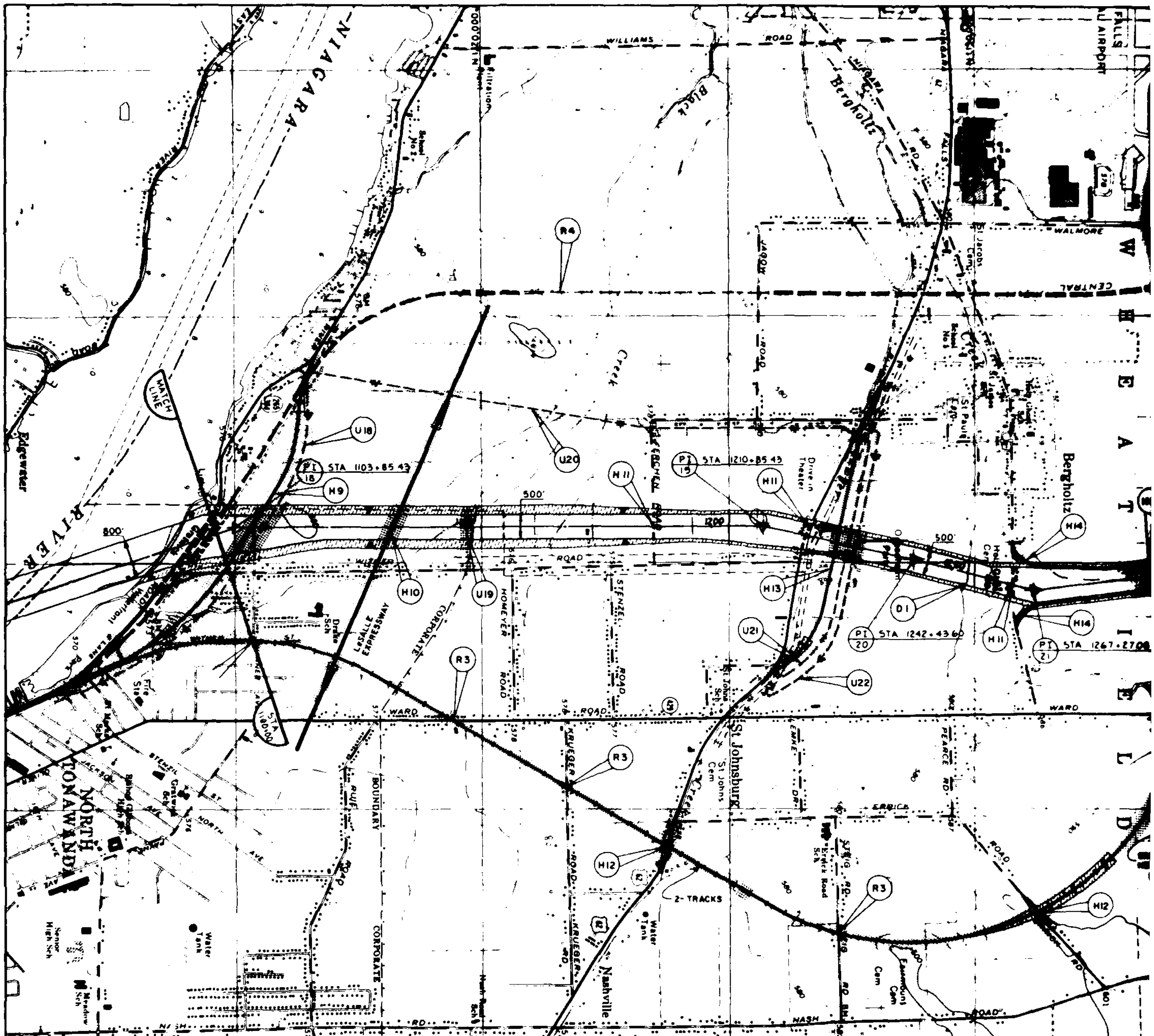
PLAN AND PROFILE

STA. 800+00 to 1100+00

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, BUFFALO

PLATE A4



UTILITIES

- U18 — RELOCATION OF 16" H.P. GAS LINE (ON BRIDGE)
- U19 — RAISING OF POWER LINES
- U20 — NEW 8" WATER LINE
- U21 — RELOCATION OF 18" WATER LINE (ON BRIDGE)
- U22 — RELOCATION OF 16" H.P. GAS LINE (ON BRIDGE)
- U23 — RELOCATION OF 4" H.P. GAS LINE (ON BRIDGE)
- U24 — RELOCATION OF 30" WATER LINE (ON BRIDGE)
- U25 — RELOCATION OF 10" WATER LINE (ON BRIDGE)

HIGHWAYS

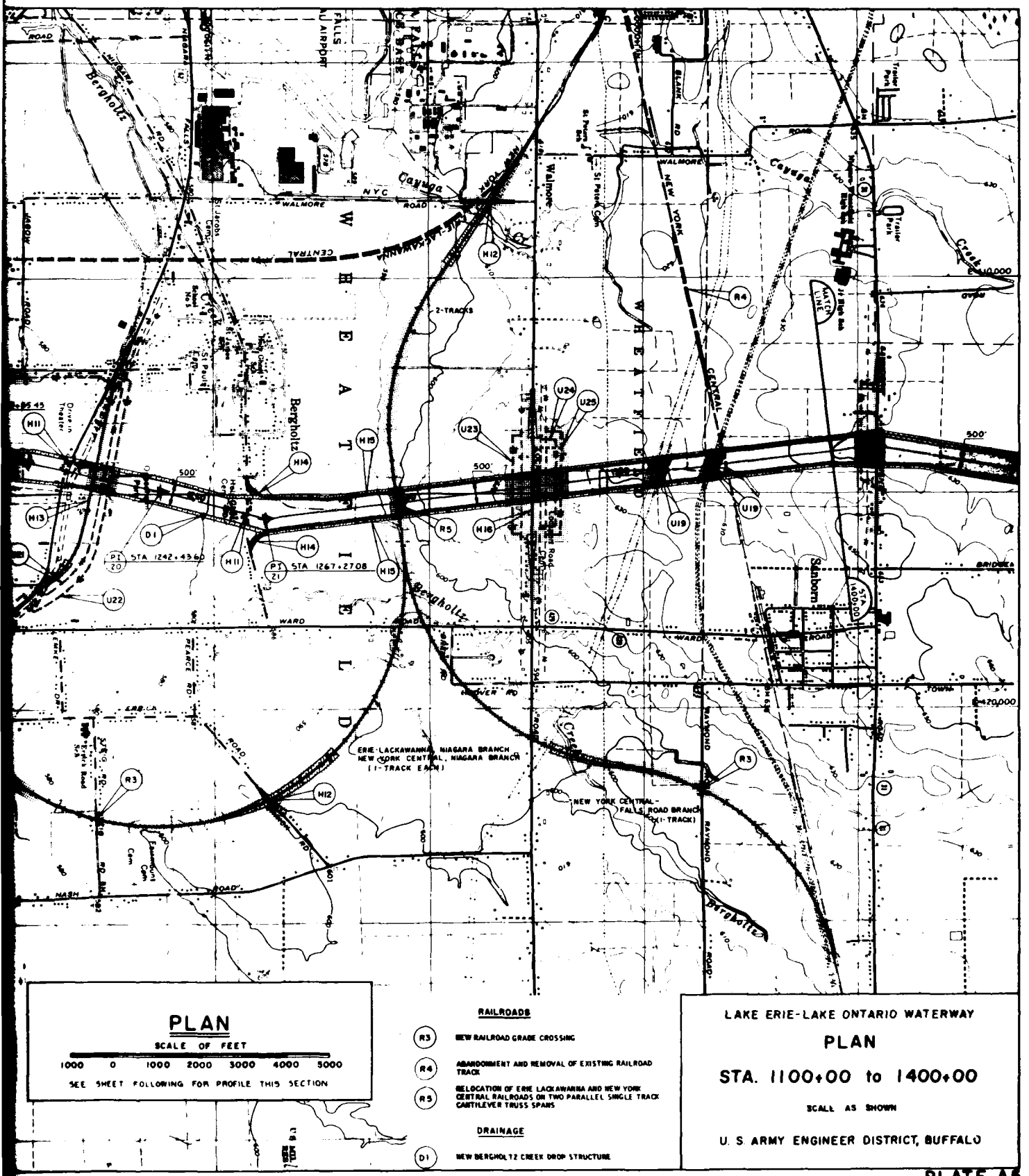
- H9 — RELOCATION OF RIVER ROAD ON NEW TWO LANE SUSPENSION BRIDGE
- H10 — RELOCATION OF PROPOSED LA SALLE EXPRESSWAY ON NEW FOUR LANE SUSPENSION BRIDGE
- H11 — ABANDON ROAD
- H12 — NEW HIGHWAY UNDERPASS
- H13 — RELOCATION OF NIAGARA FALLS BOULEVARD ON NEW FOUR LANE SUSPENSION BRIDGE
- H14 — NEW ACCESS RAMP TO BERM ROAD
- H15 — NEW BERM ROAD
- H16 — RELOCATION OF LOCKPORT ROAD ON NEW TWO LANE SUSPENSION BRIDGE

PLAN

SCALE OF FEET

1000 0 1000 2000 3000 4000 5000

SEE SHEET FOLLOWING FOR PROFILE THIS SECTION



PLAN

SCALE OF FEET

1000 0 1000 2000 3000 4000 5000

SEE SHEET FOLLOWING FOR PROFILE THIS SECTION

RAILROADS

(R3) NEW RAILROAD GRADE CROSSING

(R4) ABANDONMENT AND REMOVAL OF EXISTING RAILROAD TRACK

(R5) RELOCATION OF ERIE LACKAWANNA AND NEW YORK CENTRAL RAILROADS ON TWO PARALLEL SINGLE TRACK CANTILEVER TRUSS SPANS

DRAINAGE

(D1) NEW BERGHOLTZ CREEK DROP STRUCTURE

LAKE ERIE-LAKE ONTARIO WATERWAY

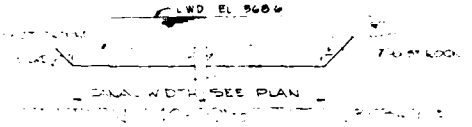
PLAN

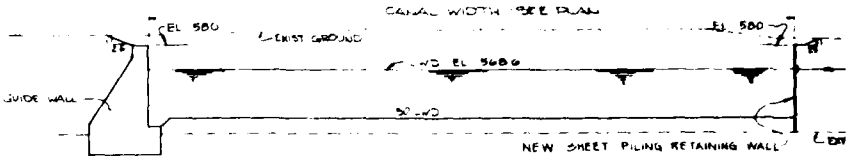
STA. 1100+00 to 1400+00

SCALE AS SHOWN

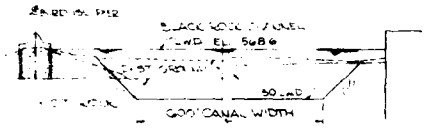
U. S. ARMY ENGINEER DISTRICT, BUFFALO

PLATE A5

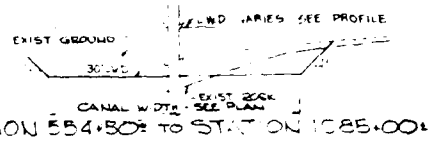




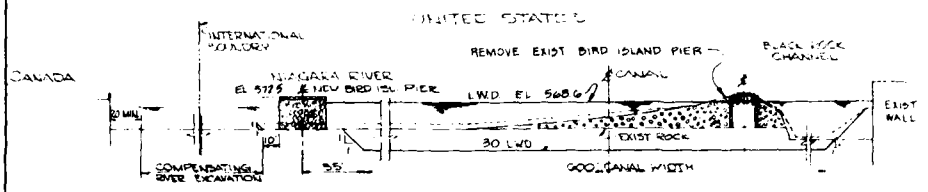
STATION 15+00± TO STATION 5+00±



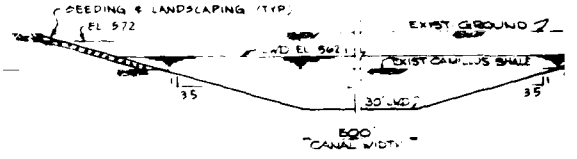
STATION 554+50± TO STATION 304+50±



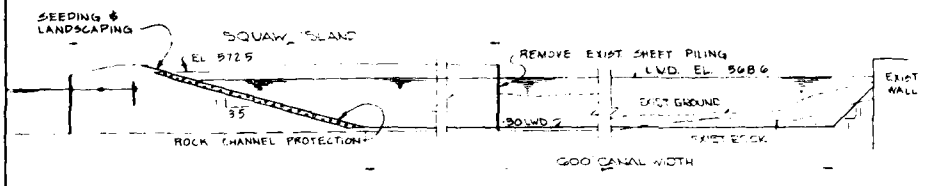
STATION 554+50± TO STATION 1085+00±



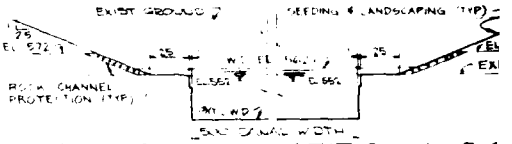
STATION 304+50± TO STATION 46?+70±



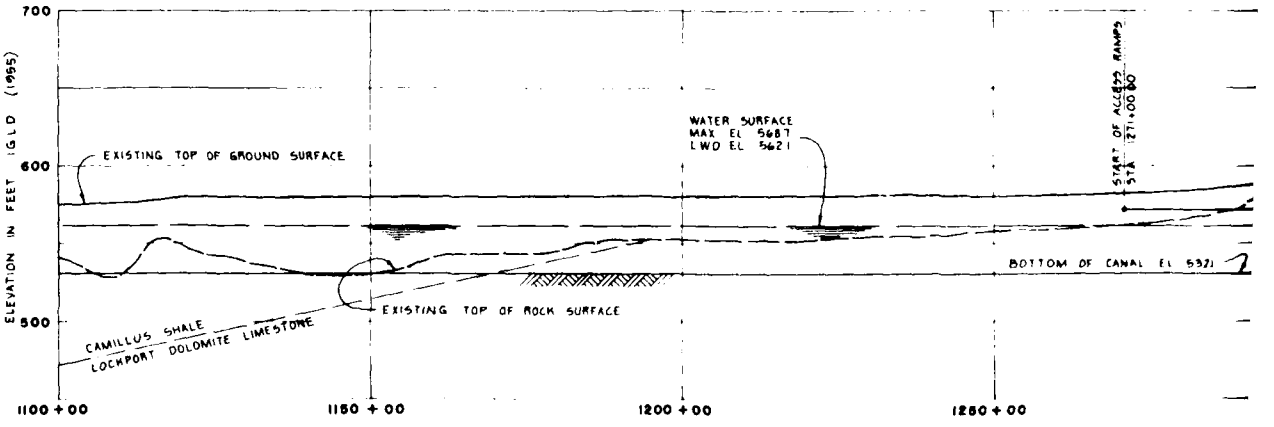
STATION [illegible]



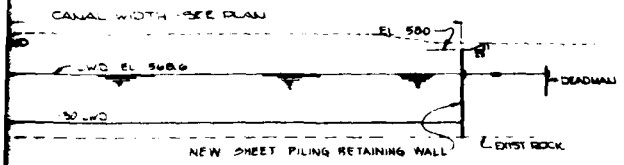
STATION 467+50± TO STATION 42?+??±



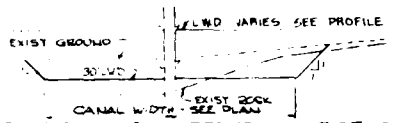
STATION 65+00± TO STATION [illegible]



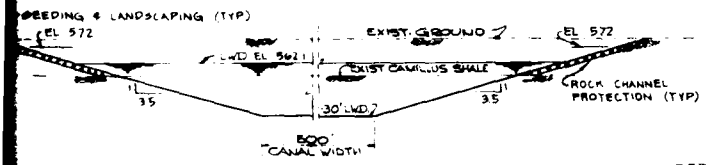
PROFILE



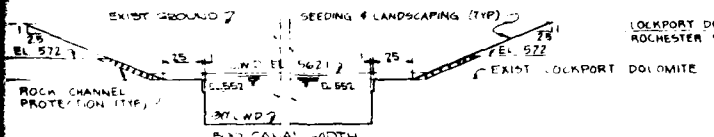
STATION 497+30± TO STATION 515+00±



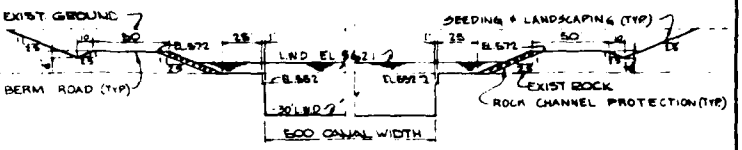
STATION 554+50± TO STATION 1085+00±



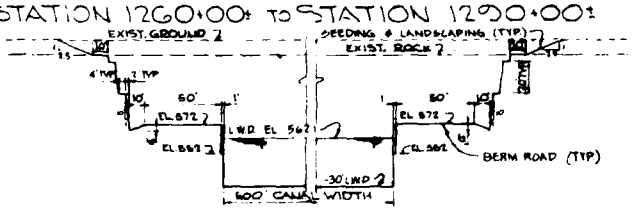
STATION [illegible] TO STATION 1125+00±



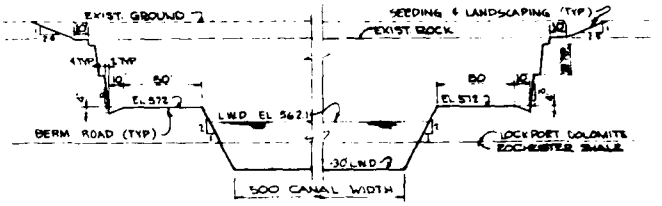
STATION 1125+00± TO STATION 1260+00±



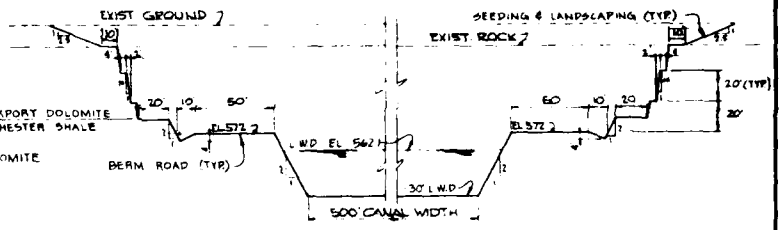
STATION 1260+00± TO STATION 1290+00±



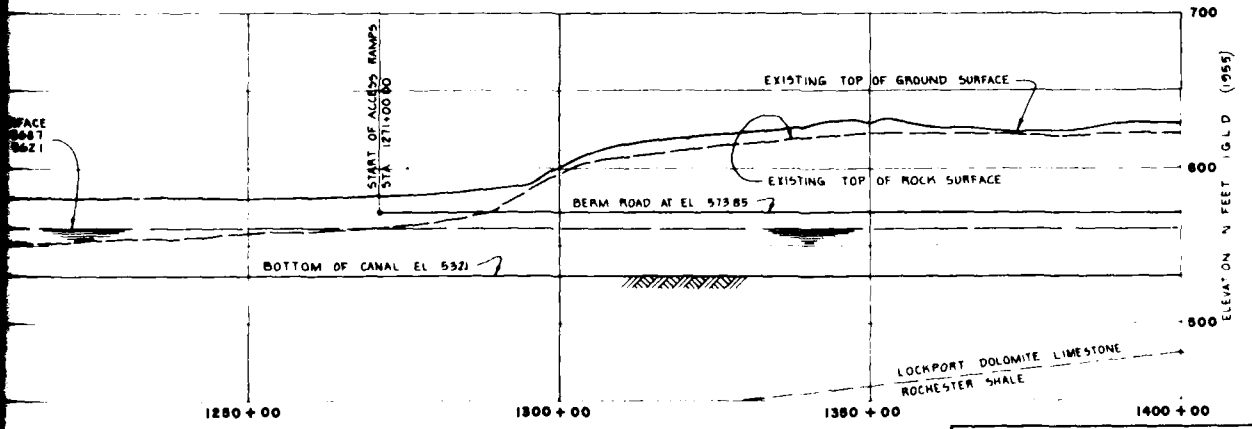
STATION 1290+00± TO STATION 1450+00±



STATION 1450+00± TO STATION 1494+00±



STATION 1494+00± TO STATION 1504+00±



PROFILE

LAKE ERIE-LAKE ONTARIO WATERWAY

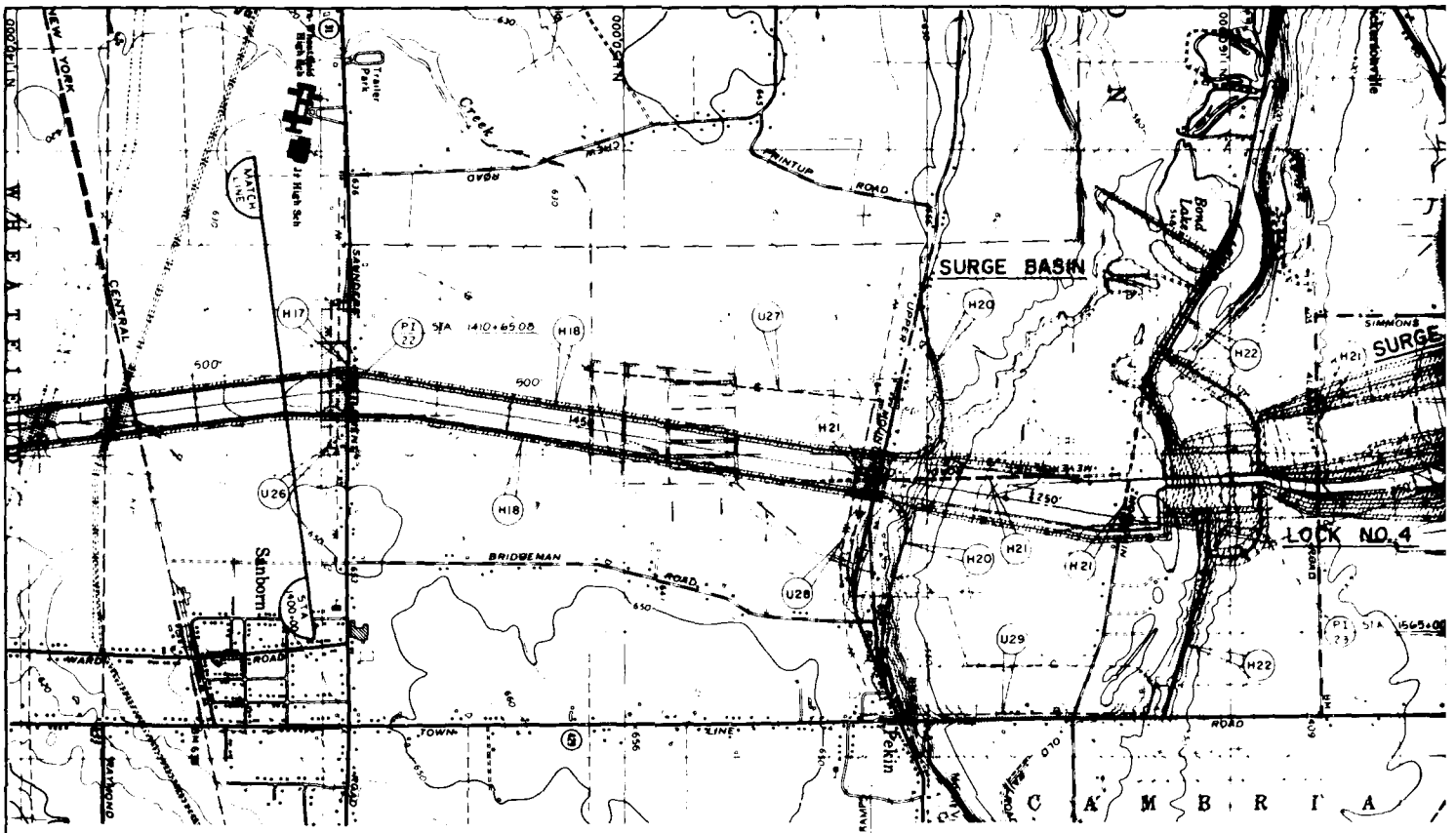
PROFILE AND SECTIONS

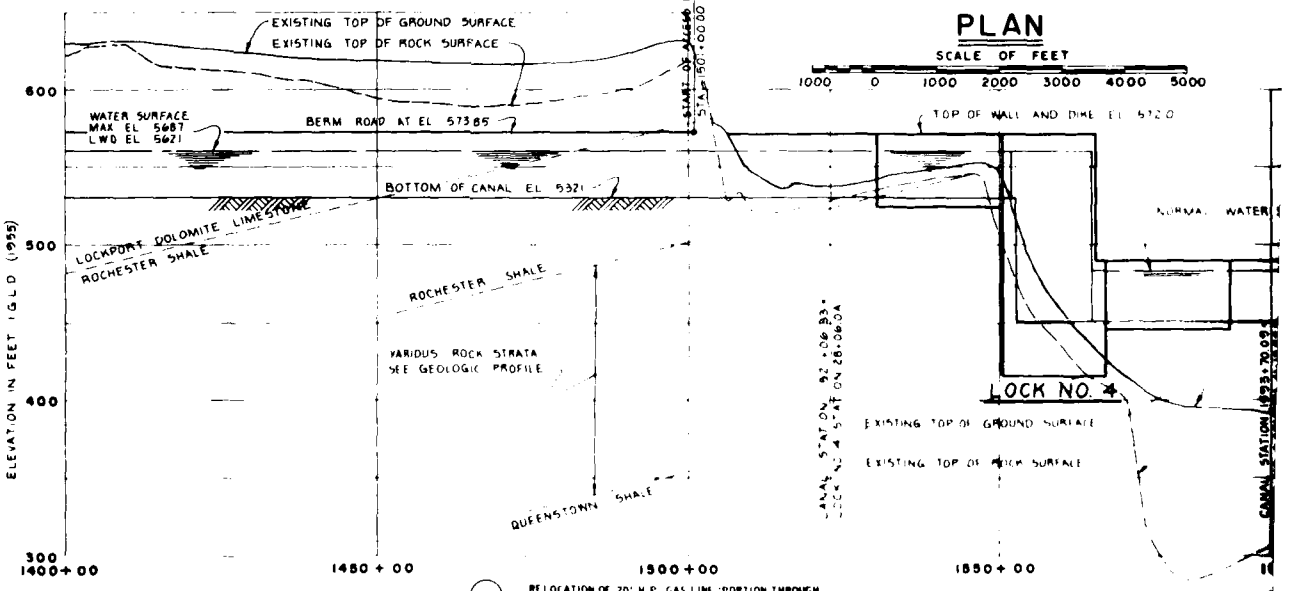
STA. 1100+00 to 1400+00

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, BUFFALO

PLATE A6



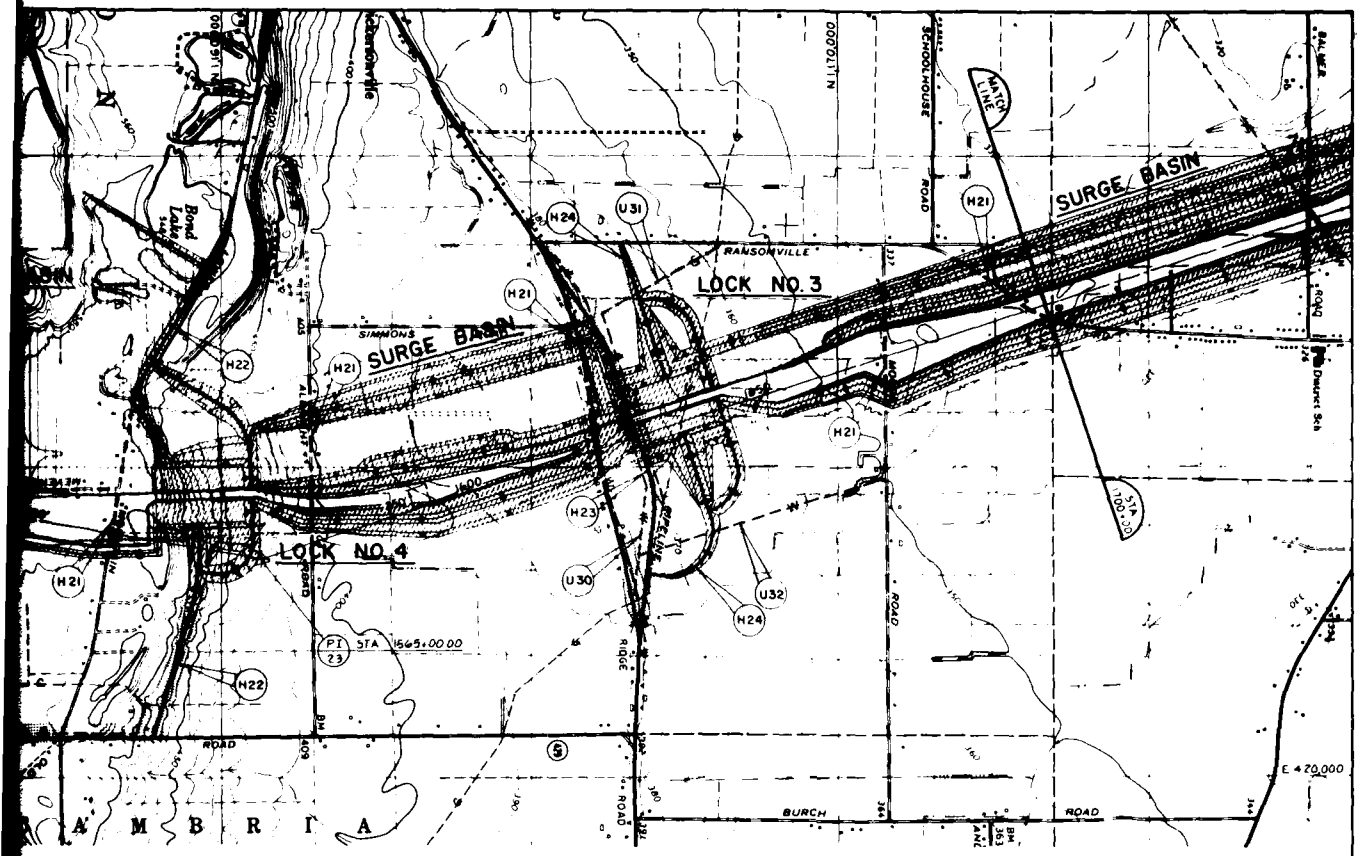


UTILITIES

U26	RELOCATION OF 12" WATER LINE (ON BRIDGE)
U27	RELOCATION OF 12" H.P. GAS LINE (PORTION ON BRIDGE)
U28	RELOCATION OF 12" WATER LINE (ON BRIDGE)
U29	RELOCATION OF 12" H.P. GAS LINE
U30	RELOCATION OF 12" WATER LINE (PORTION THROUGH LOCK NO 3)
U31	RELOCATION OF 20" H.P. GAS LINE (PORTION THROUGH LOCK NO 3)
U32	NEW R. WATER LINE

HIGHWAYS

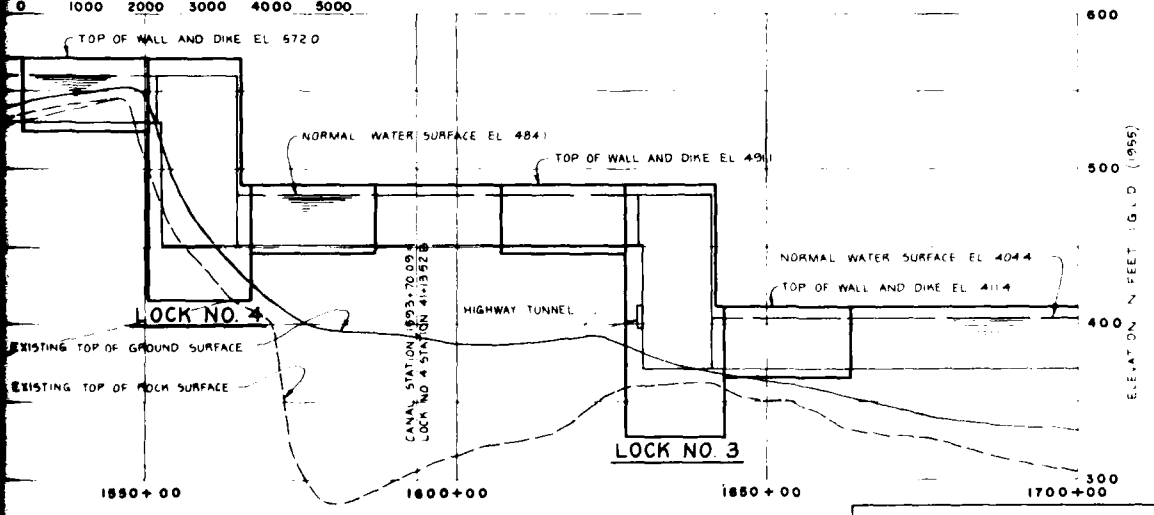
H17	RELOCATION OF SAUNDERS SETTLEMENT ROAD ON NEW TWO LANE SUSPENSION BRIDGE
H18	NEW BERM ROAD
H19	RELOCATION OF UPPER MOUNTAIN ROAD ON NEW TWO LANE SUSPENSION BRIDGE
H20	NEW ACCESS
H21	ABANDON
H22	NEW ACCESS
H23	RELOCATIO TUNNEL
H24	NEW ACCES



PLAN

SCALE OF FEET

0 1000 2000 3000 4000 5000



PROFILE

HIGHWAYS (CON'T.)

- (H20) NEW ACCESS RAMP TO BERM ROAD
- (H21) ABANDON ROAD
- (H22) NEW ACCESS ROAD TO LOCK NO 4
- (H23) RELOCATION OF RIDGE ROAD THROUGH NEW TWO LANE TUNNEL
- (H24) NEW ACCESS ROAD TO LOCK NO 3

LAKE ERIE-LAKE ONTARIO WATERWAY

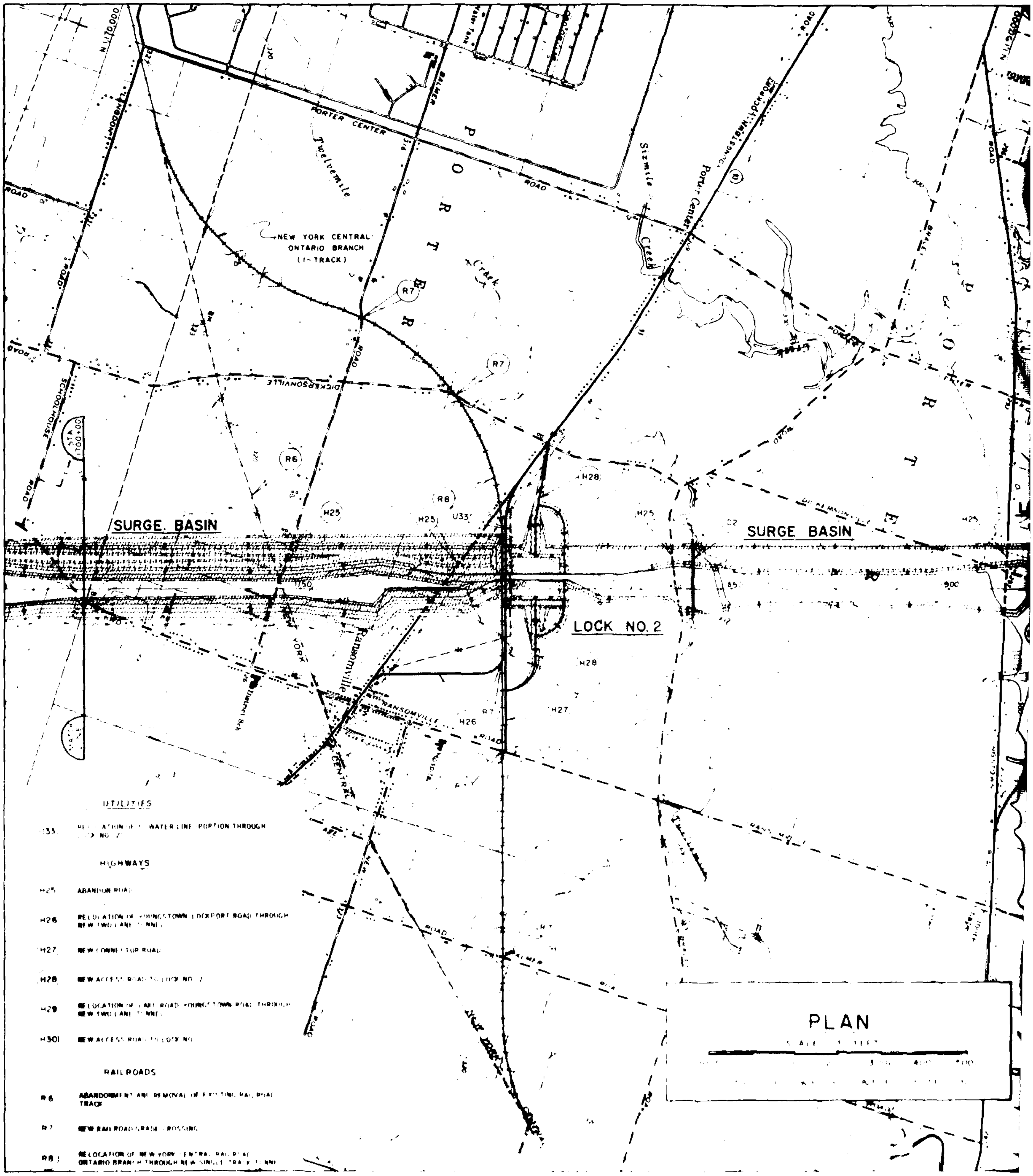
PLAN AND PROFILE

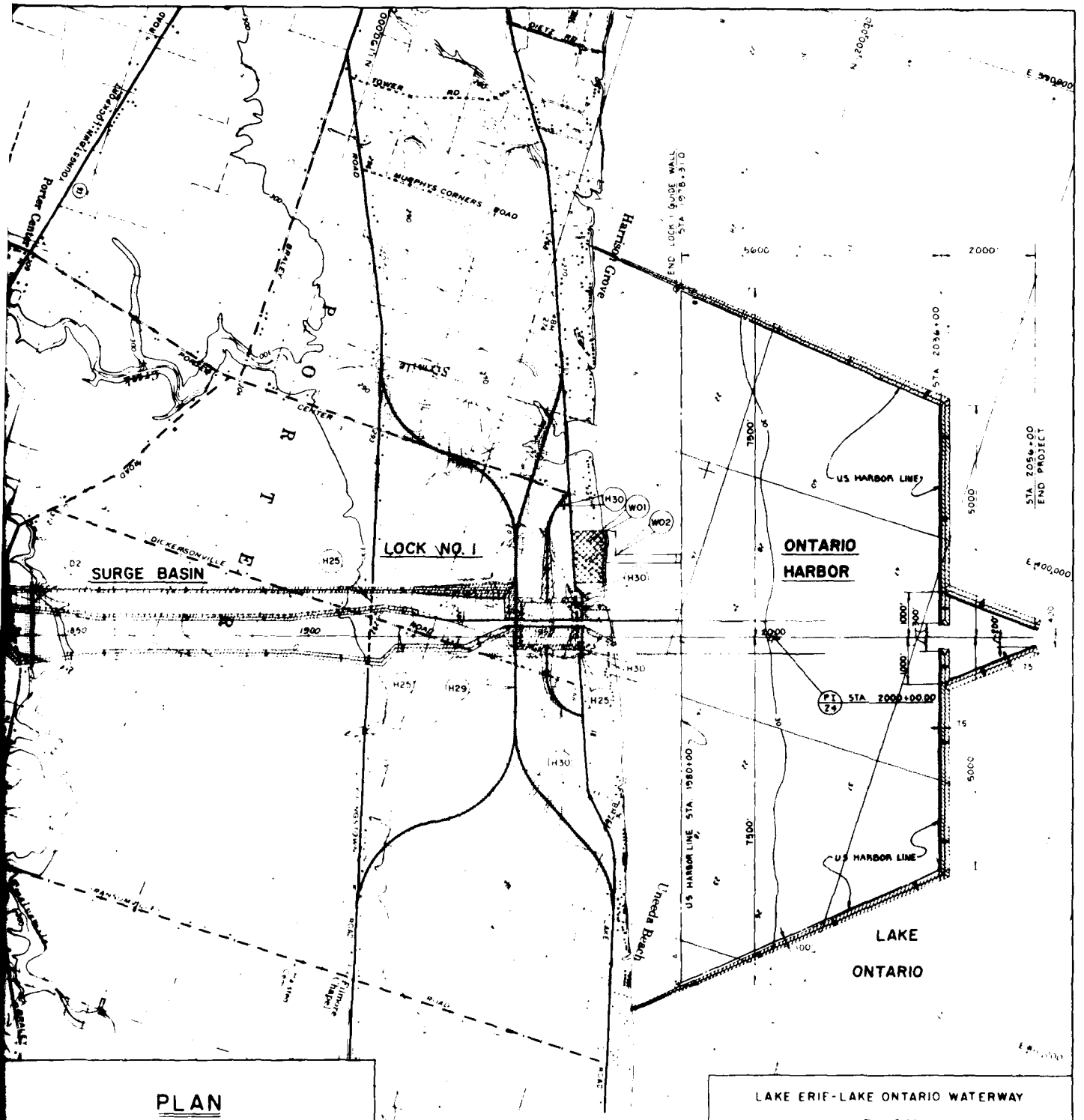
STA. 1400+00 to 1700+00

SCALE AS SHOWN

U S ARMY ENGINEER DISTRICT, BUFFALO

PLATE A7


SURGE BASIN
SURGE BASIN
LOCK NO. 2
NEW YORK CENTRAL
ONTARIO BRANCH
(1-TRACK)
PORTER CENTER
ROAD
DICKERSONVILLE
SCHOOLHOUSE
Twelvemile
Sixmile
Creek
Porter Center
Ransomville
RANSOMVILLE
YORK
CENTRAL
PORTER
R6
R7
R7
R8
H25
H25
H25
H26
H27
H28
H28
U33
UTILITIES
HIGHWAYS
RAILROADS
NEW RAILROAD GRADE CROSSING
PLAN



PLAN

SCALE OF FEET

1000 0 1000 2000 3000 4000 5000

DRAINAGE

D2 NEW INVERTED SIPHON FOR CARRYING TWELVE MILE CREEK UNDER CANAL

WATERWAY OPERATIONS

W01 CANAL MAINTENANCE AND WAREHOUSE FACILITIES, ADMINISTRATION BUILDING AND TRAFFIC CONTROL FACILITIES

W02 MAINTENANCE MOORING BASIN

LAKE ERIE-LAKE ONTARIO WATERWAY

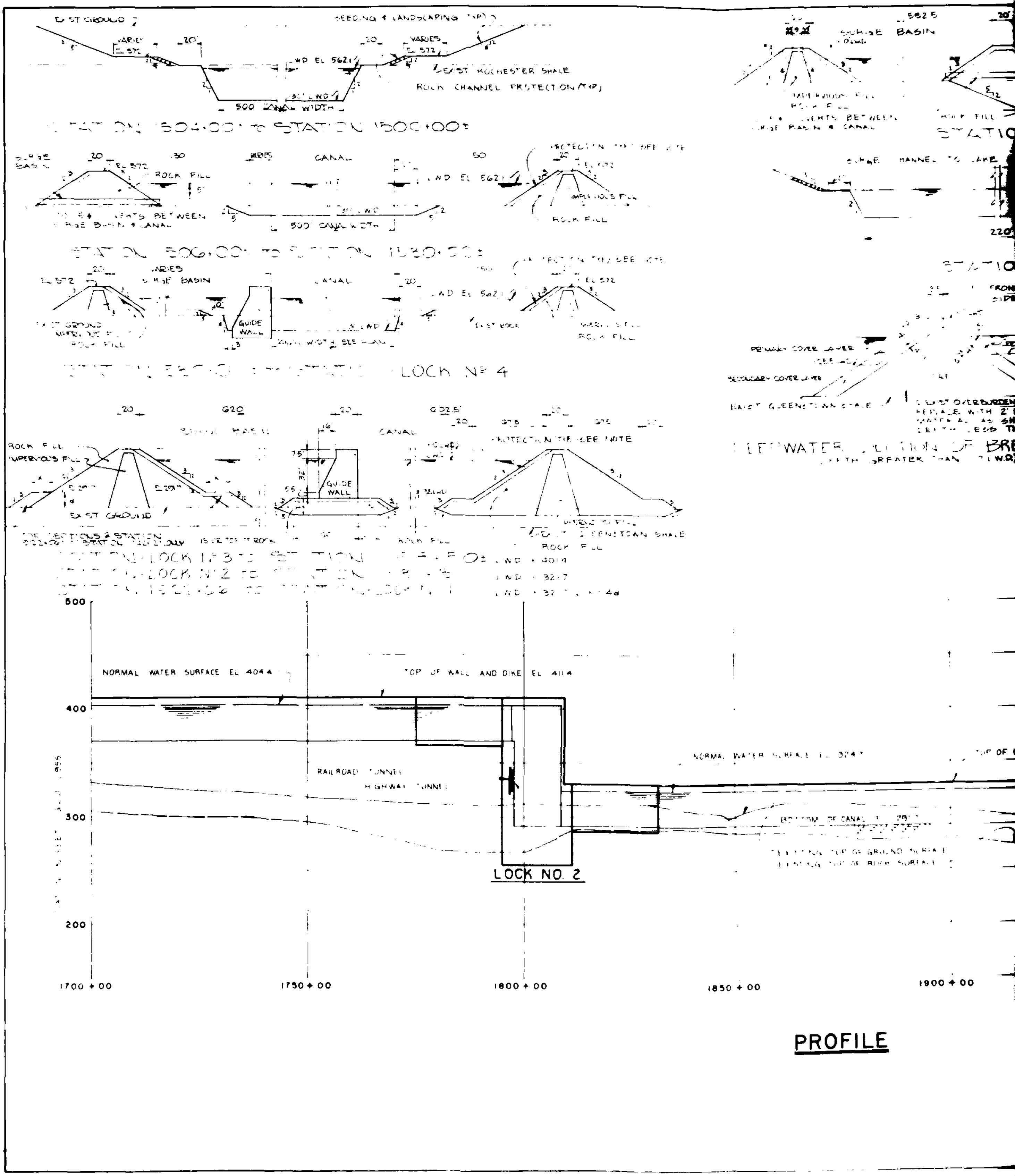
PLAN

STA. 1700+00 to 2056+00

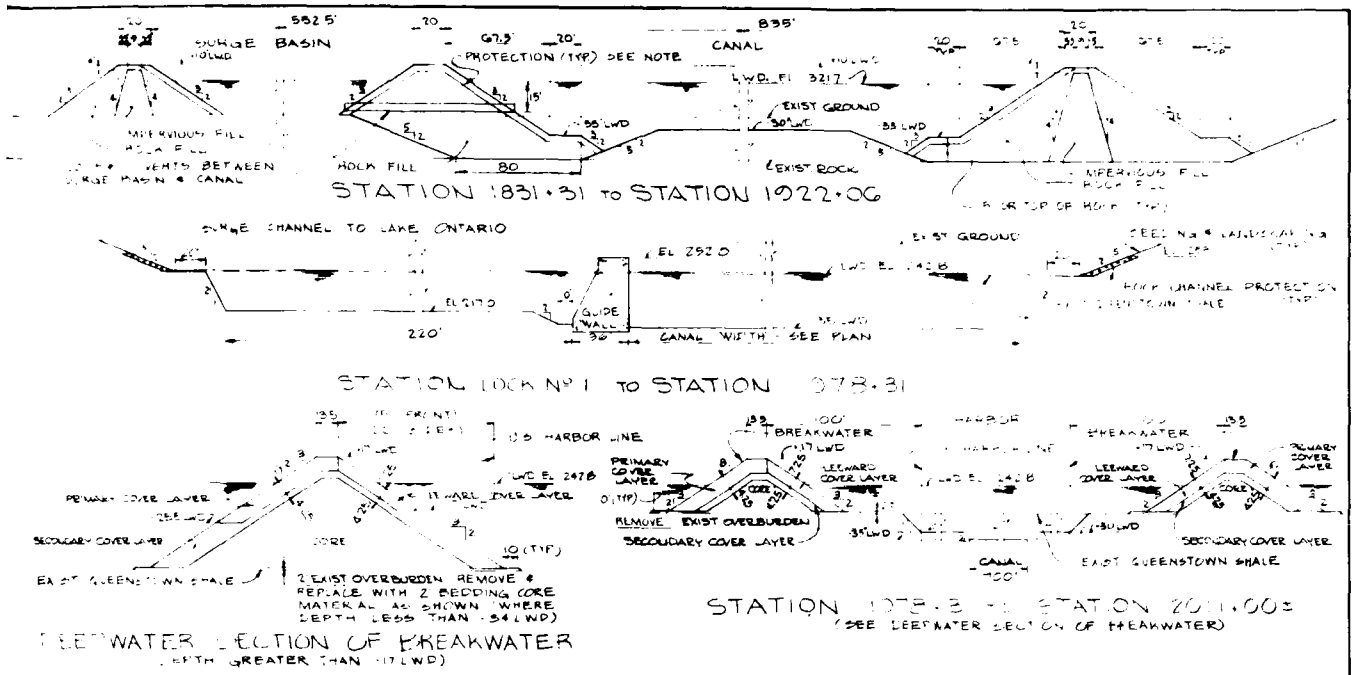
SCALE AS SHOWN

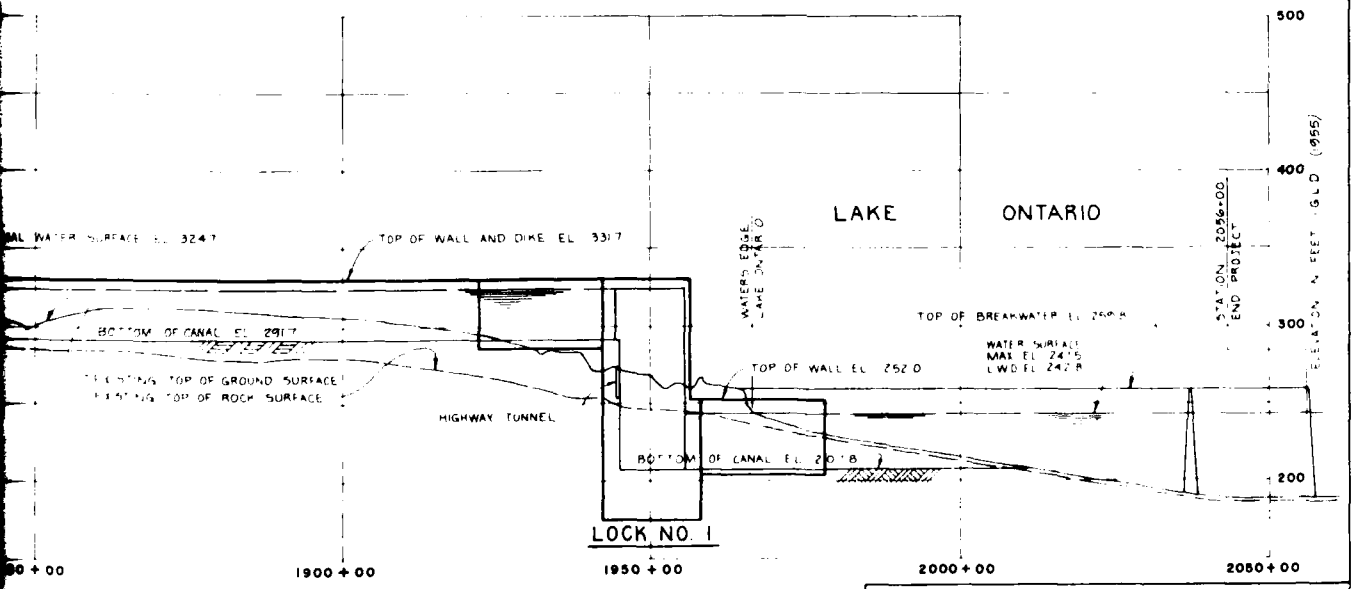
U S ARMY ENGINEER DISTRICT, BUFFALO

PLATE A8


EXIST GROUND
SEEDING & LANDSCAPING (TYP)
LWD EL 562.1
EXIST ROCHESTER SHALE
ROCK CHANNEL PROTECTION (TYP)
500' CANAL WIDTH
SURGE BASIN
ROCK FILL
CANAL
IMPERVIOUS FILL
GUIDE WALL
LOCK Nº 4
EXIST QUEENSTON SHALE
PRIMARY COVER LAYER
SECONDARY COVER LAYER
NORMAL WATER SURFACE EL 404.4
TOP OF WALL AND DIKE EL 411.4
RAILROAD TUNNEL
HIGHWAY TUNNEL
LOCK NO. 2
500
400
300
200
1700 + 00
1750 + 00
1800 + 00
1850 + 00
1900 + 00

PROFILE





PROFILE

LAKE ERIE-LAKE ONTARIO WATERWAY

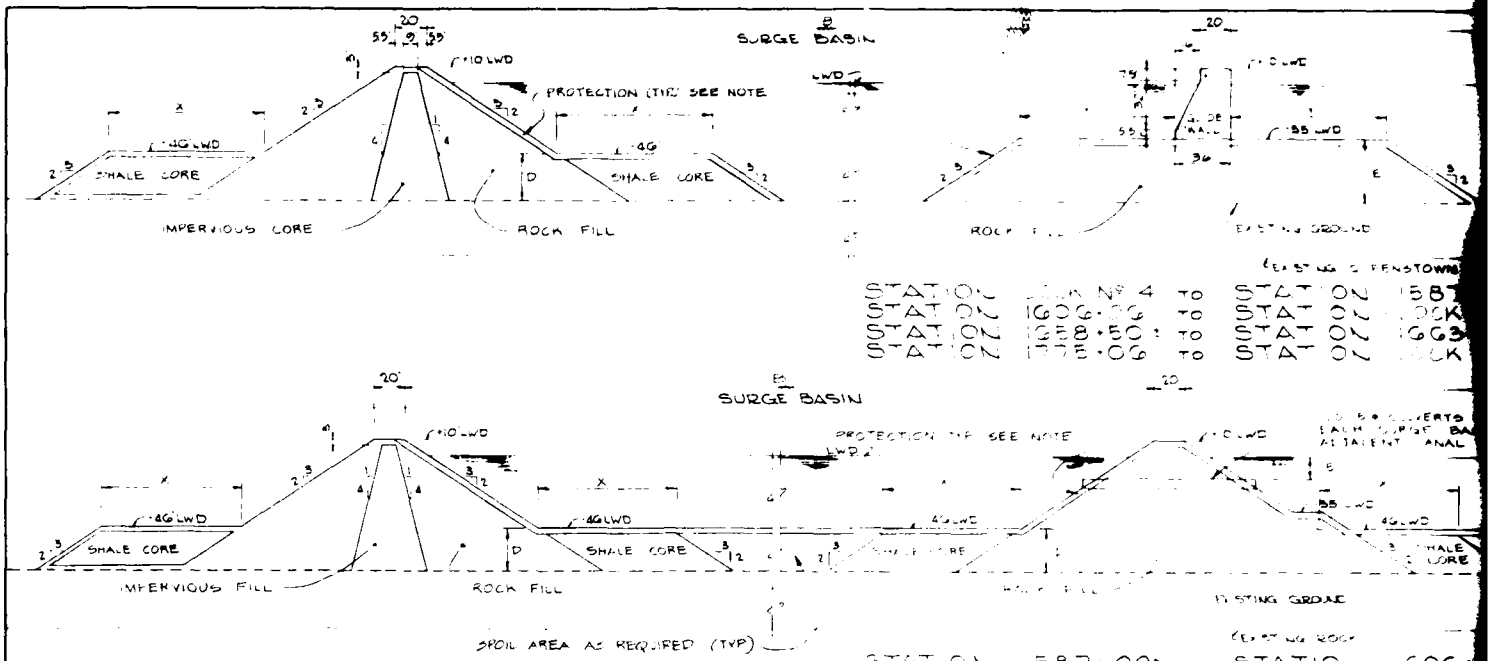
PROFILE AND SECTIONS

STA. 1700+00 to 2056+00

SCALE AS SHOWN

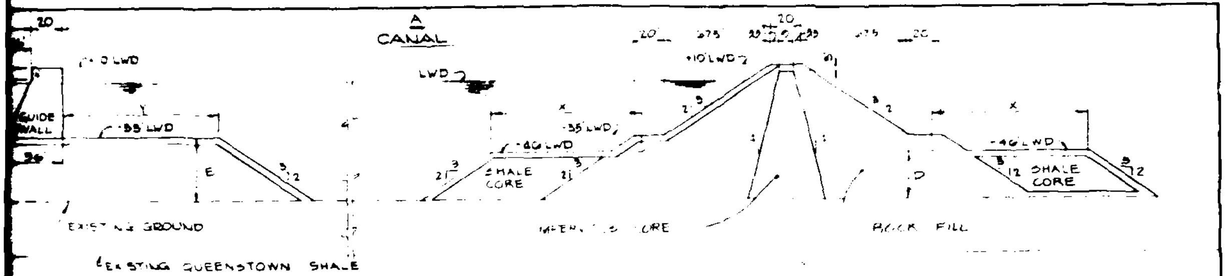
U S ARMY ENGINEER DISTRICT, BUFFALO

PLATE A9

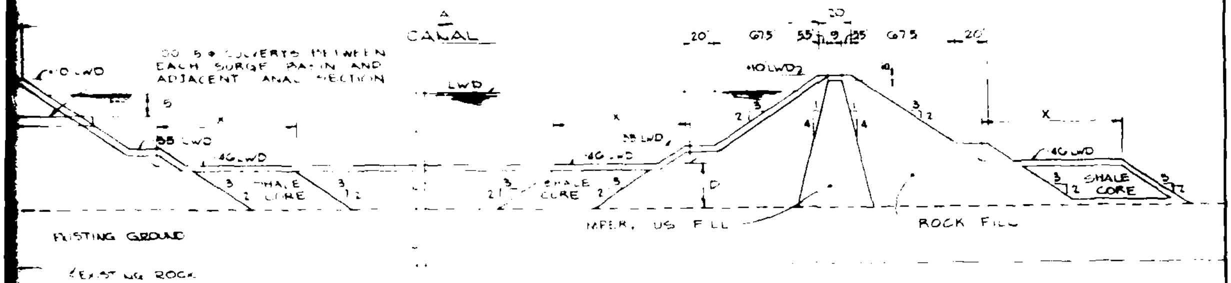


STATION	[illegible] No 4	TO	STATION	587
STATION	1606.[illegible]	TO	STATION	[illegible]K
STATION	1658.50[illegible]	TO	STATION	663
STATION	1[illegible].06	TO	STATION	[illegible]K

STATION	587+00[illegible]	TO	STATION	606
STATION	1663+2[illegible]	TO	STATION	775



STATION 1587+00 ... LWD = 481, X = 33D ... 25E, A = ... B = VARIES
STATION ... LOCK Nº 3 ... LWD = 481, X = 33D, ... 25E, A = 602.5', B = VARIES
STATION 1663+21 ... LWD = 401.4, X = 38D, ... 28E, A = 602.5', B = 620'
STATION ... LOCK Nº 2 ... LWD = 401.4, X = 38D, ... 28E, A = 602.5', B = 620'



STATION 1606+06 ... LWD = 481, X = 33D, A = VARIES, B = VARIES
STATION 1775+06 ... LWD = 401.4, X = 38D, A = 835', B = 620'

NOTE: ALL ROCK FILL DIKES ARE TO HAVE ADEQUATE SIZE ROCKS IN THEIR FACING TO PROVIDE FOR PROTECTION AGAINST WAVE & PROPELLER ACTION.

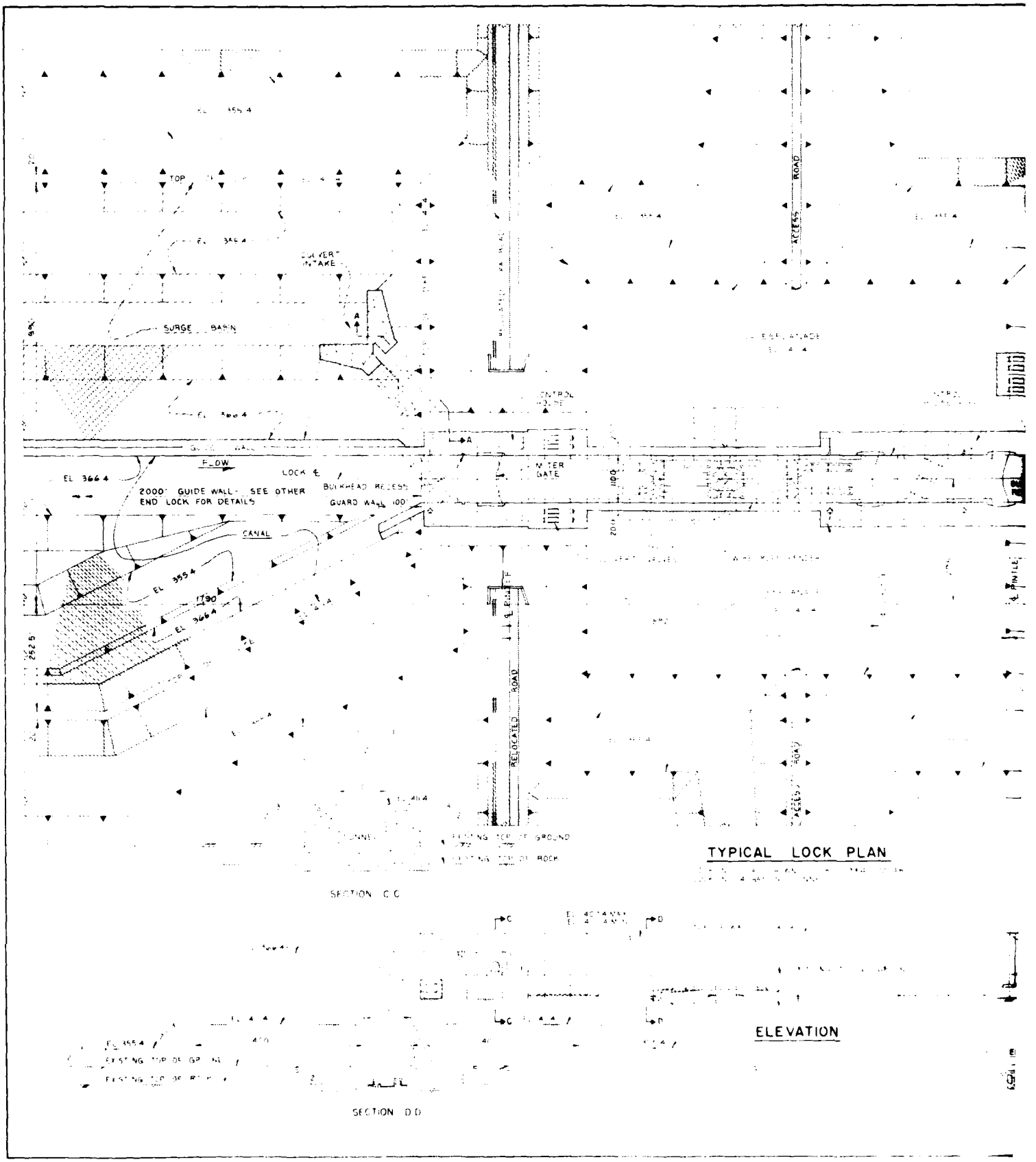
LAKE ERIE-LAKE ONTARIO WATERWAY

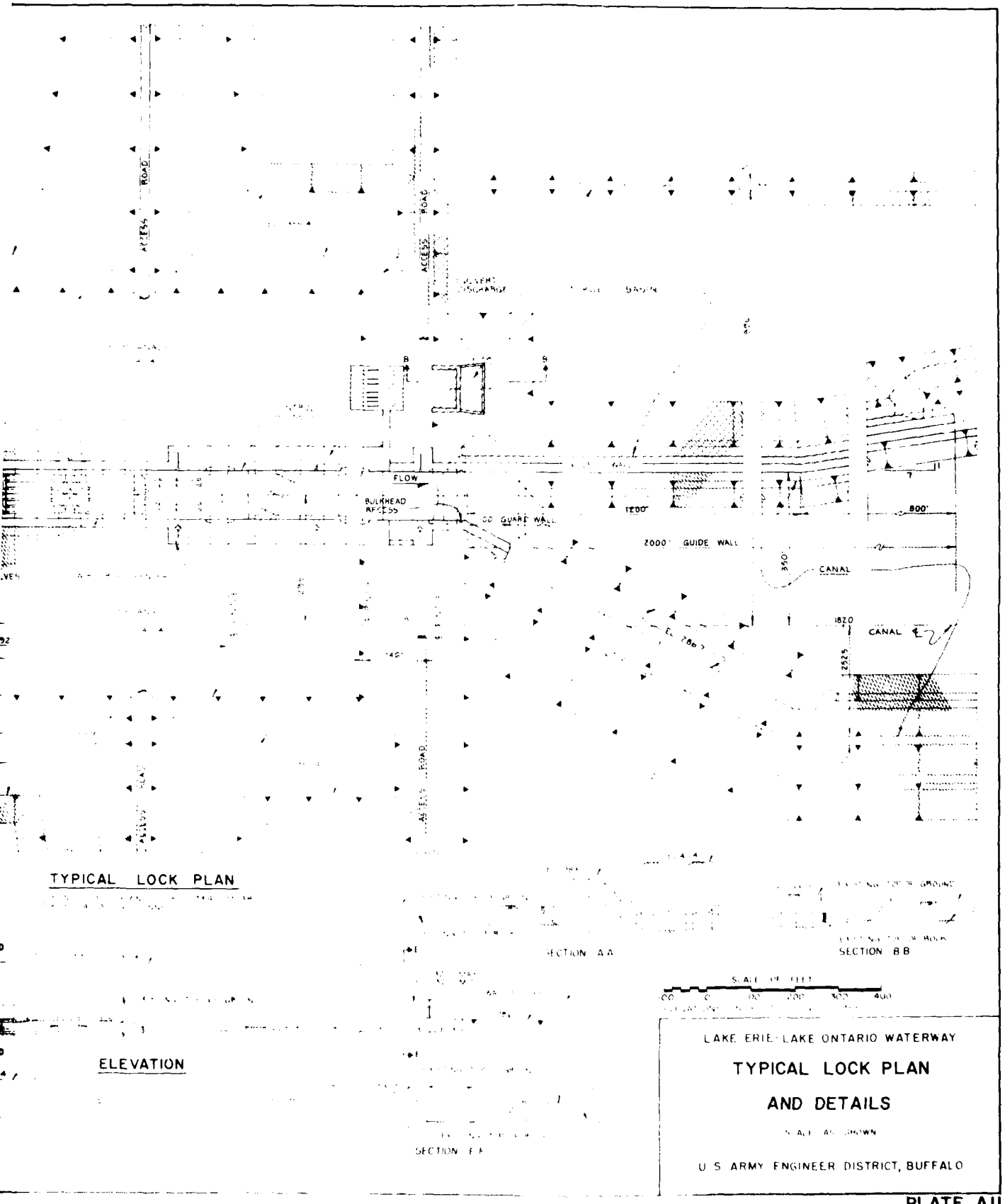
SECTIONS

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, BUFFALO

PLATE A10


TOP
SURGE BASIN
CULVERT INTAKE
ACCESS ROAD
CONTROL HOUSE
FLOW
LOCK ℄
2000' GUIDE WALL - SEE OTHER END LOCK FOR DETAILS
BULKHEAD RECESS
GUARD WALL 100'
WATER GATE
CANAL
EL 366.4
EL 355.4
1790
252.5
RELOCATED ROAD
EXISTING TOP OF GROUND
EXISTING TOP OF ROCK
SECTION C-C
TYPICAL LOCK PLAN
ELEVATION
SECTION D-D



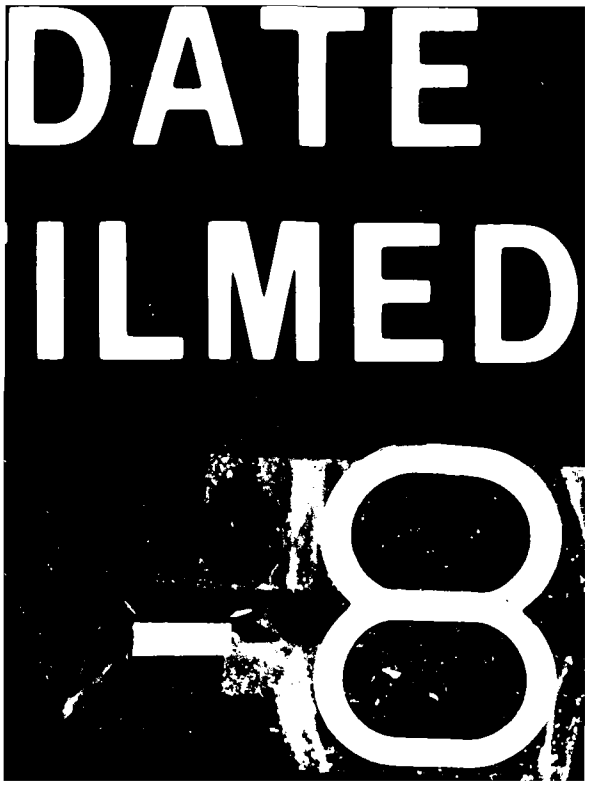
LAKE ERIE-LAKE ONTARIO WATERWAY

TYPICAL LOCK PLAN AND DETAILS

SCALE AS SHOWN

U S ARMY ENGINEER DISTRICT, BUFFALO

PLATE A11


DATE
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-8